INDUSTRIAL ORGANIZATION

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FACTORY MANAGEMENT
PROBLEMS OF PLANT AND EQUIPMENT
WAGE PAYMENT PLANS
PRODUCTION AND INSPECTION

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INDUSTRIAL ORGANIZATION

I—WORKING OUT A PLAN OF CONTROL

II—BUILDING AND EQUIPPING THE PLANT

III—SELECTING A WAGE PAYMENT METHOD

IV—GETTING OUT THE PRODUCT

SPECIAL ILLUSTRATIONS

PART I—WORKING OUT A PLAN OF CONTROL

The Habit of Efficiency

FIRST of all, efficiency is not strenuousness. The man who hustles may or may not be efficient; probably he is not. Hustling is not a normal element in efficiency, nor is strenuous work apt to be efficient just because it is strenuous.

You work at a lathe with the castings you are finishing piled ten feet away. This means strenuous, but not efficient, labor. To work at that same lathe with the castings piled so near that you can get them without moving from your place is less strenuous, but far more efficient labor.

We are familiar with the fact that an overloaded machine leads a strenuous life. None of us will, if we understand mechanics, say that it is an efficient life. This is true of men as well as of machines; true of us as well as of our employees.

We must get rid of the idea that strenuousness and efficiency are either similar or the same. Driving is one thing; efficiency is something else.

William C. Redfield

WILLIAM C. REDFIELD

Secretary of Commerce

I

APPLYING NEW IDEAS OF MANAGEMENT

By Harry Franklin Porter, M. E.

IF HIGHLY organized businesses are characterized by one thing more than all others, it is the evidence of the exercise of plan and forethought in every detail of operation. The manager who does nothing without a carefully worked out plan and strives incessantly to conform his business to his plans, has already a scientific viewpoint on management.

In business and in manufacturing, wherever the old, unsystematic methods still obtain, confusion is found, low efficiency, high production costs, a keen struggle for existence. But where the reign of common sense has been established, where everything has been reduced to a system, orderliness, dispatch, neatness, system, smooth operation, high efficiency, low production costs, prosperity are likely to be the rule.

Scientific control of work begins before even a location is selected. Everything must be considered in its relation to and bearing upon production costs and ultimate results. If a mistake is made in location, if the center of gravity of markets, sources of raw materials, fuel supply, labor market, and transportation facilities has not been struck, the business will feel the handicap all the days of its existence—until the mistake is rectified.

If the buildings in plan and details, in materials of

construction and equipment are not the most efficient and economical in the broad sense—looking at final economy, not mere lowest first cost, the business will feel this handicap, too, until what mistakes were made are rectified, either by remodeling or rebuilding entire. That managers are awakening to this fact is evidenced by the wave of remodeling and rebuilding which is sweeping over the country at the present time. Managers are finding that in the gain due to taking up the slack and eliminating the "back hauls" in production, in the saving on insurance rates, in the increased efficiency of their labor, due to better heating, lighting, ventilation and sanitation, in the attraction and holding of a better grade of help—it has been proved that workers gravitate naturally and irresistibly to the most improved factories and offices—and in countless other ways it pays and pays well either to remodel their present establishments or scrap them and build and equip new ones completely.

SCIENTIFIC *management seeks to get the most from money, materials, machines, methods and men—how to conduct finances and handle raw materials.*

If early mistakes are made in financing, bad results also will follow. In fact, sound financing is absolutely essential to success. It is far better to grow slowly than to grow fast and go into debt, if going into debt means surrendering control. No manager can have a free hand and push ahead as he would like to, when his plant is so heavily obligated to financial interests that he must submit to their dictation every step of the way and whose costs of production are so overburdened by interest charges that he is at a serious disadvantage in competition with manufacturers who are free from bonded in-

debtedness. At least one automobile company has taken advantage of its freedom from bonded indebtedness to make a telling point in their advertisements. They showed that, as compared with six other companies producing cars about the same class as their own, their cars carried a burden of nearly $300 less per car. Consequently, for a less price, they were able to give equal quality. The time is coming when the success of many factories will depend on low interest charges.

It is scientific management to finance so as to entail the minimum burden due to interest charges on the cost of production, as well as to get the most for one's money in buildings and equipment.

As to money, so in regard to materials, machines, methods and men. How to get the most out of these five M's is the idea behind scientific management.

Applied to *materials* scientific control means first of all a strict accounting for every scrap of material used. As carefully as most businesses do, and all should, keep track of every penny received and every penny disbursed, so in the scientifically managed plant is the balance of materials kept. Here the manager sees as an accountant, for scientific storekeeping takes its cue from scientific cash-keeping.

All materials not being worked on are kept in storage, under lock and key, in charge of a storekeeper, who is held strictly responsible. No material is issued except on duly authorized requisition, and what material is issued is carefully charged either to a job order or to a manufacturing expense account, so that it all gets into the costs, leaving no unaccounted-for consumption to be charged to profit and loss when the yearly inventory is taken. Each fresh receipt of material is as carefully accounted for, being added to the balance on hand.

By keeping a card record of receipts and disbursements of material and by checking up balances systematically, the old-fashioned burdensome and expensive once-a-year taking of inventory is rendered unnecessary.

By fixing maximum and minimum limits, an over supply is avoided on the one hand and a shortage on the other.

Thus, by providing the purchasing agent with proper specifications and inspecting receipts of material to see that the specifications have been agreed to, and that the weight and count are right, the policy of keeping sufficient supplies of suitable materials on hand is reduced to a routine—becomes virtually automatic.

Handling material at least cost and most expediently, minimizing waste and spoliation, and getting material to the workman as he needs it instead of compelling him to hunt it up, are further phases of the application of scientific management to this element of manufacturing, and phases wherein the elements, machines, methods and men play a conspicuous part.

HOW *to arrange and handle machines to get most out of your invested capital—functions of the production department and how it operates.*

Handling of *machines* comes next. The scientific way does not consist so much in making machines perform operations as largely as practicable (although it is scientific to do nothing by hand that can be done better, more quickly and more economically by machine), as it does in managing machine operations so as to get the most out of the capital thereby represented.

The finest automatic machine in the world would be worthless without proper direction. Nor would it be worth its salt if not kept constantly turning out work.

To keep it regularly busy requires: *first,* a proper volume of work; *second,* proper handling of work so that it flows to the machine as fast as it can be used, but no faster, and is taken away as promptly; *third,* proper maintenance so that interruptions do not occur due to breakdowns or neglect to oil; *fourth,* proper handling devices at the machines so that the work may be handled in and out of the machine most expediently; *fifth,* proper illumination, so that the operator is not inconvenienced and delayed by lack of sufficient light when and where needed; *sixth,* that the cutting tools are kept sharp, by some other than the operator; *seventh,* that only work is given a machine for which it is adapted and that it is worked up to its capacity at all times; *eighth,* that a careful record is kept of the performance of each machine, its output, consumption of power, cost for repairs, and so on, so that not only may the cost of the operation be definitely known, but the efficiency of each unit as a dividend producer.

Much good at this point can come from records. The production manager must establish records of machine performance and boil them down for the quick information of the busy executive—information that he and his staff need to enable them to *plan ahead.*

Methods, the next element to be considered, is a broadly inclusive term, which in its broadest sense embraces all the other elements. In the sense used here, however, its meaning will be restricted principally to methods of production and costs.

The keystone in the arch of manufacturing methods is the *planning* department, sometimes called the production department.

In a small factory the planning department will be very simple, perhaps comprising only one man who acts

as an assistant to the manager, relieving him of all routine work. Proportionately as the factory increases in size and scope of activity must the *planning* department be larger, dividing up the routine work of management among as many different individuals as necessary, in order that no one has more duties to attend to than he can handle conveniently and effectively.

This department handles all orders as received, analyzing them, getting out the production orders necessary, referring matters requiring new designs and specifications to the engineering department, which in this scheme of management is subsidiary to the planning department; *sees* to it that the supply of raw materials, supplies, tools, and so on, is always adequate and that no order is sent into the factory until the materials and tools required for it are on hand; that work is assigned the proper machines and railroaded through on schedule; that shipments are made as promised and followed through to safe delivery; that every machine and every operative in the establishment have each day sufficient work assigned ahead so that none will be without work any appreciable length of time, nor be compelled to hunt up new work, nor yet to be idle because of delinquent repairs; and so on.

This in brief is the function of the *planning* department—its work is literally to do all the planning of a routine nature in the establishment, leaving the executives free for creative planning and the workers to execute solely.

It is in the separation of the planning from the doing that scientific methods make their biggest saving over the old regime, wherein much of the planning in addition to the execution is shouldered on the workmen, thus considerably curtailing their efficiency as producers.

The cost system in the scientifically controlled plant becomes chiefly an instrument of control, and the cost department a subsidiary of the planning department, furnishing to the planners the records and statistics by means of which they assign work and control the cost thereof. Its importance as a mere cost-getter, however, is by no means lessened; on the contrary, it is if anything heightened. For in order to plan effectively detailed knowledge is necessary not only of the manufacturing cost of each article of product, but of the cost by operations, the cost with different machines and with different men. Only in this way can the efficiencies of the various production factors be established on a firm foundation and efforts to improve conditions, increasing output and decreasing costs, reduced to a program. The cost system becomes, thus, the mighty instrumentality of *standardization*—the watch-word of industrial efficiency.

TIMING *operations by the stop-watch and setting rates according to the "one best" way—how functional bosses replace the old line foreman.*

But the cost system is not relied on solely to help forward the work of standardization. The *rate setter,* an attaché of the planning department, plays a most important part. His it is to establish by stop-watch analysis the best ways of doing operations and set standard times, upon the basis of which men's rates of pay are fixed and by means of which the planners are enabled effectively to plan the work of each man and each machine in the factory.

Under less advanced managing methods all knowledge as to times required to do different pieces of work, what this man and that machine could do, and so on, resided in the head of the foreman, and depending on

that worthy's keenness of observation, retentiveness of memory and sense of values was worth little or much, usually little, as an instrument of standardization and cost reduction. And under the old system, too, the foreman set the rates, upon the basis of his own experience and personal recollection, by watching a workman for an hour or two, or simply by the use of that magic calculating machine—"judgment"—that is, by guess. All this is changed under scientific control.

The timing of operations and the setting of rates is taken out of the hands of the foremen entirely and vested in a specialist who does nothing else and thus becomes very proficient. The rate setter makes the fullest use of the cost statistics compiled by the cost department but merely as a guide to deeper probing. And his timings, finally, not the average figures of the cost clerk, become the standard.

There are other duties formerly vested in the foreman, which, under the Taylor system, are taken from him and vested in separate functionaries. Four of these are attachés of the planning department: the *order of work* clerk, who instructs both foremen and men as to what work to take up next and on what machines to do it; the *instruction card men,* who are responsible for all the detailed instructions as to work, the rates that are to be paid, and so on; the *time* and *cost clerk,* who sends to the men all the information they need, via their work or instruction cards, to enable them properly to report, secures from them the proper records, and refers the information gathered to the cost and time entry clerks; and the *disciplinarian,* or peacemaker, who acts for the whole factory, to settle disputes between different foremen and different men, and who, very largely, handles wage adjustments.

The four functional foremen in the factory proper are: the *speed boss,* to whom the workmen look for instructions as to the tools and the proper speeds and feeds to use; the *repair boss,* who is responsible for the condition of all machines and work places, the proper piling of work, and so on; the *inspector,* who is responsible for the quality of all work, and to him both the men and the speed boss must look in this respect; and, finally, the *gang boss,* or foreman proper, who is responsible for all work up to the time it is put in the machines, must see that there is at all times sufficient work ahead, and that the men are properly instructed how to do their work. He is the pacemaker, the instructor, and friend of the workmen, whose duty is to help them in every way he can, not only to do good work, but the largest quantity possible.

By this arrangement the position of foreman is not lowered in dignity—it is if anything enhanced. It is simply a case of greater specialization of duties, and in this instance, as in general specialization, does not degrade but elevate. It is of course hard to make men inured in the old system believe this fact—they feel humiliated at first and oppose the change bitterly; but when finally won over to the new plan, they become enthusiastic about it and would not go back to the old condition for love or money.

Nor does this multiplication of "bosses" complicate the work of supervision, as might be offhand, and is so very generally, supposed. "Too many bosses" is indeed a great evil, but it is one far more prevalent under the old style of management, where there is seldom a clean-cut division of duties and a logical arrangement of lines of authority, than under the new plan, in which clean-cut division of duties and responsibilities is a

fundamental principle. When men know exactly to whom to look for different classes of instruction, and the men who are looked to know exactly the compass of their authority, there is no chance either for overlapping authorities or errors of omission in giving instructions.

Of course, in a small establishment, with few departments, it would not be practical or necessary to functionalize the supervision to the extent outlined, and several of the functions would be combined in one individual. And in any establishment, the complete individualization of these functions need be carried out to no greater extent than the size and conditions justify.

UNIFORMITY *of methods and the issuance of standard written instructions are plans adopted by scientific managers to avoid the confusion of verbal orders.*

Instructions

But no matter how little or how much the work of supervision is specialized, whether divided up among eight men or combined in one, the method of supervision under the new regime is radically different. Under the old scheme, there is almost an entire dependence on word of mouth: bosses issue their instructions verbally; men learn the standard practices of the factory from the lips of or by watching fellow workmen who have been there longer.

In consequence there is almost an entire lack of uniformity of methods; no two men do the same thing in the same way—the one best way; there is almost infinite variability in operations; on account of so much dependence on the fallible memories and perceptions of men, much repetition of the same instructions over and over again, many mistakes due to lack of clear instructions or clear perceptions.

Not so, in the thoroughly systematized plant. Instead,

there is a zealous and unremitting effort made to learn the best ways of doing everything, in which the rate setter plays a leading part, and when once the best way of doing a particular piece of work—it may be a machine operation, or a hand operation, or setting up a machine, or piling work, or inspecting product, or what not—when once the best way has been found, it is embodied in a *written* standard practice instruction, which thereafter becomes the law of the factory, until supplanted by a still better way.

The men receive their standard practice instructions on their work cards, which are made out in the planning department. The various functional bosses and heads of departments, in the office as well as in the shop, receive written instructions covering their duties, defining the policies of the management, explaining such other matters as they are vitally interested in, usually on regular letter size, typewritten sheets, which they keep in binders in a locked drawer in their desks.

As fresh issues arise concerning which no instructions —or incomplete instructions have been issued, a *bulletin* or special standard practice instruction is issued. When a certain number of bulletins have collected on any one subject, all the instructions both regular and special are recalled and revised standards prepared incorporating both. In this way, the instructions are kept up to date; each inch gained is held; confusion due to loose, verbal instructions avoided; with resultant great gain in efficiency all around.

Instructions of a general nature, in which the men are interested regardless of position, such as *shop rules,* instructions regarding fire and accident prevention, industrial insurance, description of company's product, its policy, aims, and goals, and so on, are usually incor-

porated in a little booklet, which the men receive when they enter the employ of the company and surrender when they leave.

The gain due to instituting written standard practice instructions in any factory is incalculable, and the larger the factory the greater is the gain—in fact, the efficient operation of large factories would be out of the question otherwise, and no factory is too small not to profit thereby. The function they really perform is that of standardization of supervision—they are the means of bringing about "one mind" throughout an establishment. To a certain extent they reduce the amount of supervision, in the sense of the term ordinarily understood, necessary. This is instanced by one company operating a chain of factories which has supplanted its factory managers at the several plants with a book of standard practice instructions.

MEN *are not like machines—they must be led, not driven. How the modern manager trains his employees, and induces them to work at top efficiency.*

Last, but not least, comes the handling of *men.* How is the efficiency of the workers to be built up and conserved? How are we to get, not the most, but the best out of them? Scientific management answers, by carefully fitting the man to the job and the job to the man, and once the man and the job have been mated by systematically training the man until his skill is perfected, and then by paying him, not as little as he will work for, but as much as you can afford.

Labor is the one responsive element in manufacturing, and in the last analysis efficiency and success depend very largely on how hearty a response it makes. As William C. Redfield says, "It is the greatest force in

industry; the only living force, too often a wasted force, too rarely a force used as we use an engine—reciprocally."

The proper viewpoint and the scientific viewpoint towards labor is to regard it not as an expense, to be cut down incessantly as any other expense, but as an investment, to be handled as carefully and treated as judiciously as any other investment.

It is scientific, hence, first of all to endeavor to improve working conditions to the utmost, not because it is humanitarian, but because experience has proven that it pays. The more comfortable and healthful the factory environment, the more contented the workmen, the less absence on account of ills directly traceable to bad working conditions, the more responsive, the easier to manage, the more efficient as producers.

It is also scientific to bend any effort to place men in their right positions, so that they will have the work for which they are best fitted naturally; then train them until they are familiar with the niceties of their work and fixed in the habit of doing it the right way. Only when men have been fitted to their jobs and trained to do them properly may definite quotas of work be regularly put up to them and their rate of pay based directly on their output.

THE *great problem which now confronts men in industry and commerce, and also in educational, religious and philanthropic work, is one of management and administration.*

—James Logan

Chairman Executive Board, United States Envelope Company

II

CHARTING AUTHORITIES IN THE INDUSTRIAL BODY

By Clinton E. Woods
Electrical and Mechanical Engineer and Consulting Expert

MANUFACTURE of material into a specific product is a digestive process. A functioning organism must be provided to keep the factory alive for the same reason as in the human body. It must be directed by a specific intelligence, and have internal and external avenues of correspondence to keep it alive; and, like the living organism, it must be self-supporting and more, show a reasonable profit, or it can not progress.

Organization aims to unite individuals into a body which shall work together for a common end. Specifically, organization prepares for the transaction of business by electing and appointing officers and committees, delegating authorities and bringing into systematic connection and cooperation, each and every part of the industrial body. Right organization, in short, puts vitality into the entire factory, secures the efficient working-together of all employees, from the manager's office to the mechanic's bench, routes materials, subdivides work, inspects output and delivers the right goods, fully processed, at the shipping room door on the correct delivery date.

In analyzing organization work, a single chart can frequently express more than any amount of detailed written explanation. First of all, clearly define author-

ities within your establishment; then chart those authorities simply and graphically, so that every workman knows to whom he is responsible, and every executive knows who is responsible to him. Place this chart conspicuously in every department where each employee can see it. In case of disputed authority, final proof is immediately at hand. There is then no loop-hole through which a neglectful workman, foreman or executive can crawl—no longer does he have the excuse that he "thought somebody else was going to do it." In clean-cut form, his duties and relations to other men of the organization are laid down once and for all, and responsibility rests on the right man. Failure so to specify responsibilities inevitably means confusion all down the line.

INCREASING *specialization in factory work has resulted in the growth of functional or staff control, which supplements military or line organization.*

There are two big principles in organization: "military" and "functional"; or, as they are more commonly and better called, "line" and "staff." These principles are not antagonistic. On the contrary the best possible results are often secured only when the two forms of organization exist side by side.

Line organization is the old form, in which authority proceeds in a straight line from the highest to the lowest. The workman has the foreman above him, from whom he receives all orders. The superintendent is above the foreman, and the president or general manager ranks above the superintendent. Authority proceeds down this single current in the shape of specific orders until it reaches the actual workman. Simplest and most natural, this form of organization alone, especially

in complex businesses, is not always the most effective.

Scientific management has very largely emphasized functional and staff organization—a form which is natural in an age of constantly increasing specialization. Staff organization delegates certain functions to one man in authority, who is a specialist in his line. In the army, for example, a captain in the medical corps does not attempt to build bridges. That is the duty of an engineer, who is, thus far, a functional executive in a staff organization.

The captain in the engineering corps does not outrank the captain in the medical corps, or vice versa. Each is responsible in his own field and has full authority.

Such a division of functions is made simply because a man who specializes on one kind of work can do that work much better than a man who is now commanding a battalion, but is presently called away from his ordinary functions to build bridges. A man may be a very good civil engineer, without having the ability to lead others in a military attack.

This does not do away altogether with line organization. Within his department and the scope of his own work, the staff executive exerts his authority directly, on the old line plan. In other words, line and staff exist side by side, and it is only thus that the best results are attained.

Applied to industrial bodies the principle of line and staff brings far better results than the line principle alone. The old foreman, in most up-to-date factories, is done away with and in his place there may be four functional foremen: the speed boss, the repair boss, the inspector and a gang boss. This would seem to make an undesirable addition to the number of bosses for each man. In practice, however, it is found to work out well,

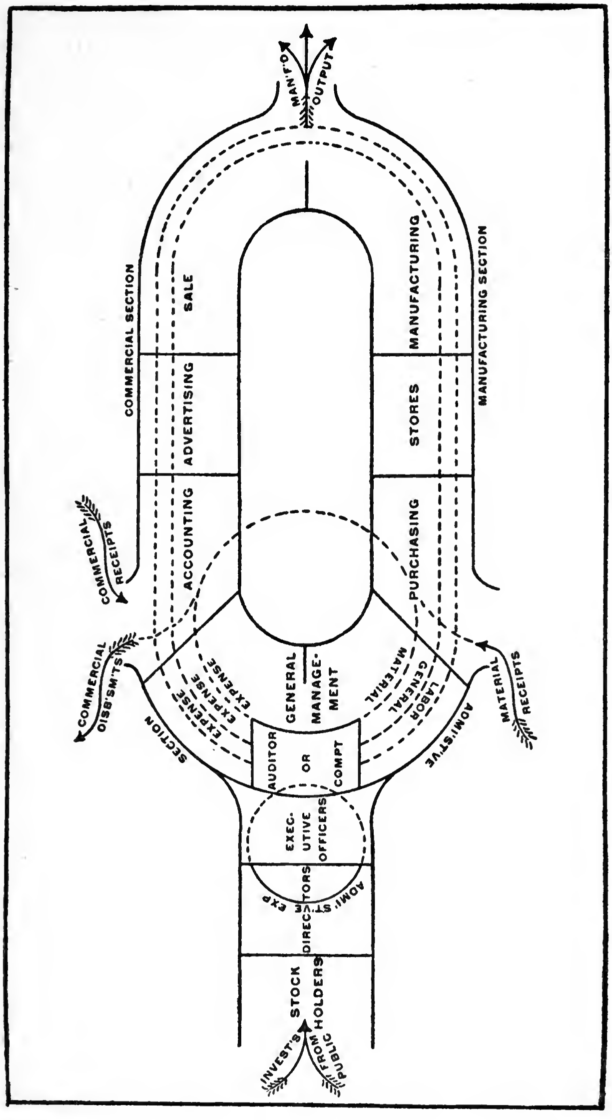


FIGURE I: Prime elements of the industrial body are shown in this chart. It illustrates how each department is related to other departments, to the executive officers and to outside commercial bodies

because each of the bosses exerts his authority in only the particular province assigned to him.

Prime elements of the industrial body are shown in Figure I. The resemblance to the human body is graphically portrayed. This industrial body has its own mind, will power and directing brain in the stockholders, directors and executive officers; it has also avenues of correspondence with the outside world which furnish it with the very elements of its existence.

WHAT *the prime elements of the industrial body are and how they are related to one another and to other bodies in the commercial world.*

Stockholders, as the chart shows, are the first connecting link between the factory and the general public. They have simply made an investment for a specific purpose, but are too unwieldy in themselves to control directly the work of organization and manufacture. They therefore at once elect directors, and the latter select executive officers who assume direct control of the functioning powers.

Final circulation of the business is kept active by the auditor or comptroller and is divided into the four factors: administration, labor, overhead and material expense. The dotted lines within the oval indicate to what extent this circulation enters into the organization as a whole. Labor permeates through all departments, material extending only to the purchase and accounting departments; while general expense permeates through all departments and is composed—as indicated by the second dotted line within the oval—of both labor and material. As administrative expense is only a local circulation and its expense comes within the administrative section, it is indicated by the lines so dotted.

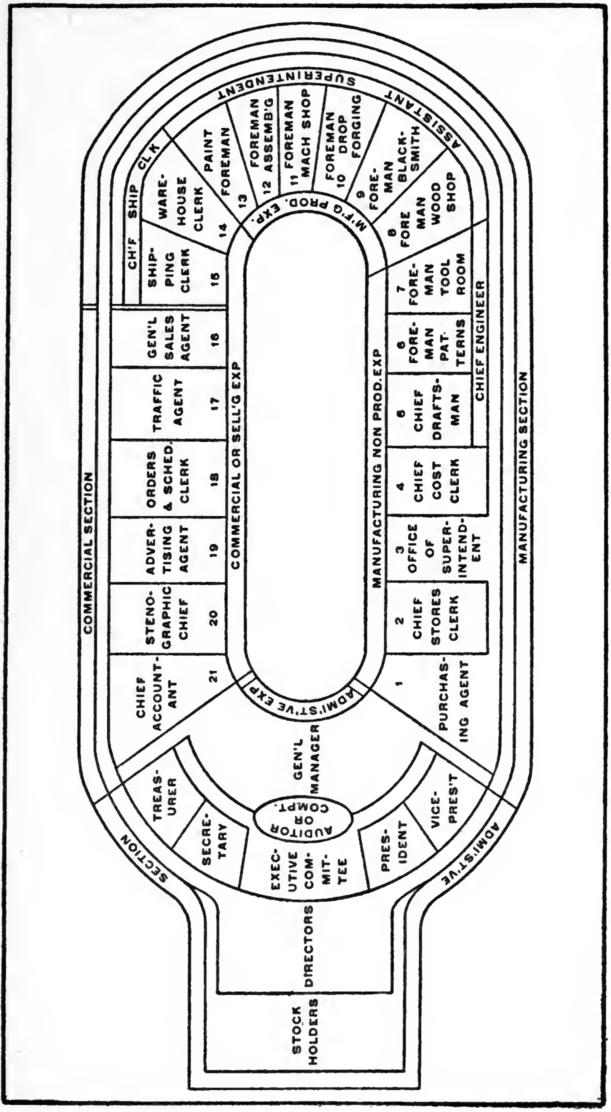


FIGURE II: This chart shows the prime and working elements of the industrial body. It indicates the essential subdivision of duties in each section of the organization

This chart also indicates what are the avenues of correspondence with the outside world. Incoming correspondence consists of, first, the stockholders who make an investment; second, material receipts; and finally, the commercial receipts. The outgoing correspondence is commercial disbursements in payment for material received and manufactured output which comes back in the form of commercial receipts.

The least number of prime elements to which a manufacturing business can be reduced and yet retain a proper functioning power is also indicated. In the manufacturing section, these prime elements are purchasing, sales and manufacture. In the commercial section come accounting, advertising and sales, with a general manager at the head of both and connecting them. No matter how small a business may be, it must have this much of a structure. No matter how large it may grow, on the other hand, it will ultimately resolve itself into simply the subdivision of these prime elements along the line of extended functioning powers.

Although here reduced to the simplest possible terms, Figure II at the same time contains all of the elements which govern the laying out of an organization of any magnitude. This is the chart of prime and working authorities, showing exactly where each authority is related to the others and how far each authority may extend in the business.

DEPARTMENTS *into which the prime elements of the industrial body are subdivided—how to chart authorities and definitely place responsibilities.*

The administrative, commercial and manufacturing sections are retained in the same position as in Figure I and these different sections are subdivided into the

specific departmental divisions for the purpose of showing how the authorities controlling different departments are related to the industrial body as a whole.

Departmental division is a necessity which is many times insufficiently understood. It means much more than a mere division of authority. It is necessary because of the fact that different methods of procedure in the making and marketing of goods require widely varying experiences with the authorities that govern them. The division of a business into departments is controlled by two elements, the character of the labor that it is necessary to employ, and the character of the material processed. Therefore, in order to know the proper divisions of the manufacturing business into departments, it is necessary, first, to trace the essential processing of material from the raw state to the finished product by progressive steps, and then lay off the departments along this line of travel in accordance with its differences in the elements above designated.

In Figure II note in the administrative section the fact that stockholders control the directors and that their paths of authority do not extend beyond this. The directors control the executive officers and form themselves, or a few of them, into the executive committee. The paths of authority for both the directors and executive committee, as indicated in the chart, are identical, but these authorities do not extend beyond the line which separates them from the space occupied by the general manager. This general manager is accessible to all of the executive officers. The auditor or comptroller of the company is closely identified with the board of directors, all the executive officers and the general manager; but his office does not extend beyond that. Charted out, his duty shows as an isolated

dotted circle, which indicates the necessary independence of this office from the interference of other executive officers.

Coming now to the general manager's path of authority, note that it extends entirely around both the manufacturing and commercial sections and that all departments coming up to the dotted line are directly answerable to the general manager for the conduct of their duties.

In department No. 1 the purchasing agent is the first sub-authority. The chief stores clerk, department No. 2, is under the purchasing agent and communicates with the general manager only through him. Department No. 3, which is the office of the superintendent, has a path of authority extending under the general manager as far as the manufacturing section goes. Sub-authorities under him are the chief engineer, assistant superintendent and chief shipping clerk; under whom another division into sub-authorities is indicated by departments Nos. 5 to 15 inclusive.

This method of procedure in charting organization is very effective since it sets definitely and exactly the lines of authority, and allows the number of subdivisions of authority that any business may require.

The prime distribution of expense is another interesting group. This shows, first, the confines of the administrative expense; second, the manufacturing nonproductive expense; third, the manufacturing productive expense; fourth, the commercial or selling expense. This method of procedure is so flexible in the chart that it can be divided up to meet the requirements of any business.

One point to note in connection with this chart is the fact that while the shipping departments and ware-

house are under the authority of the superintendent, their expense is a commercial or selling expense.

The laying out of such a chart as this is the foundation for the proper distribution of all administrative duties, and when carefully laid out specifically to meet the needs of your business, clears up more questionable points and avoids more disputes regarding authorities and duties than any other method.

Once laid out, a copy of the chart should be placed in the hands of every individual having authority. In actual organization charts for your own business, fill in each department space the names of the heads of the department, and also the names of all sub-authorities, so that your chart shows not only what is here exhibited as fundamental, but also gives the entire personnel of the organization down even to the ordinary day laborer.

Application of new ideas has generally to be made to plants already in existence. In analyzing your plant for the purpose of determining how to produce most economically always bear in mind the fact that the first thing to be desired is the direct movement of your product along the lines that lead from raw material to finished product, irrespective of any geographical departmental condition or location already established, as it is only by this means that possible re-arrangements are attained.

With such a chart as Figure II arranged on this basis, with departments put in sequence throughout the manufacturing section in accordance with the different movements required in the processing of material, it then becomes easy to take geographical conditions into consideration and to arrange them in such a way as to make the movement of the product which is being manufactured continuous in one direction.

This kind of chart with its subdivision of authorities clears up many causes for dispute, and every man knows exactly what is expected of him. Since this is true, since every man knows what he is responsible for, and to whom he is responsible, it is possible to place accurately the blame for mistakes and neglected duties. Much of this neglect, therefore, and many of the mistakes which ordinarily occur are then automatically done away with.

RESPONSIBLE *heads are demanded in every modern manufacturing establishment. At the desk of the chief executive, be he called variously the factory manager, shop superintendent or production manager, there must be focused in compact form the substance of all the factors entering production. By this means alone can the factory output be regulated and the most efficient use made of men, materials and machinery.*

—Edward T. Runge
Factory Organizer and Cost Accountant

III

CENTRALIZING FACTORY CONTROL

By Edward M. Stradley
Factory Organizer and Accountant

WITHOUT the groundwork upon which to erect an efficient productive unit, executive control of factory detail is impossible. The old-time policy of governing a plant by inspiring the efforts of department heads through a tacit understanding of their relative positions, is fast giving way to the belief that a well organized factory exists only when a fixed and definite statement of the responsibility is outlined.

Old factories and new are susceptible to this organization of the working force, but in building new plants the arrangement of the buildings also counts for much in organization. These two factors, a well-planned arrangement of buildings and a thoroughly defined responsibility, make up the basis of the most economical manufacturing plants.

Suitable building arrangement augments the efficiency of a well planned organization. In one concern, the arrangement is made up of a series of closely connected single-story structures for the manufacture of rubber hose.

One gate only gives access to the factory enclosure. It is built roomily to accommodate a two-horse wagon and the area within is large enough to turn the wagon around in. No space is wasted. Directly at the rear of

the gate the platform of the receiving department opens into a spacious raw material stock room, itself so placed in the center of the processing departments that the raw material for each can be transferred directly with the least handling. The entire factory is so planned that work moves through the buildings in straight lines.

This organization of processes is not generally possible in old factories in which growth has been haphazard and in which building arrangement has not been considered for so long a time that it is a pretty problem to rearrange completely the lines of production. The straight line is, however, the ideal in old as well as new factories. Starting with open fields, the production engineer for the new factory has none of the difficulties brought about by existing conditions and can, therefore, build his plant very closely to attain the ideal.

IMPORTANT *in every factory is thorough organization in the working force, so that each man knows his duties and the persons to whom he is responsible.*

While such organization of buildings is highly desirable, and while the ways of production are smoothed wonderfully by a well-arranged plant, a thorough organization of the working force is possible in all factories.

Men can be more easily arranged than buildings. Thorough organization of a plant is essential and a smooth running department organization will overcome a great many defects in building arrangement.

To bring out clearly the duties and relative importance of the various departments making up a factory, a typical organization diagram for a rubber mill is shown (Figure III). Naturally machine shop organization would differ in detail from this, but the general

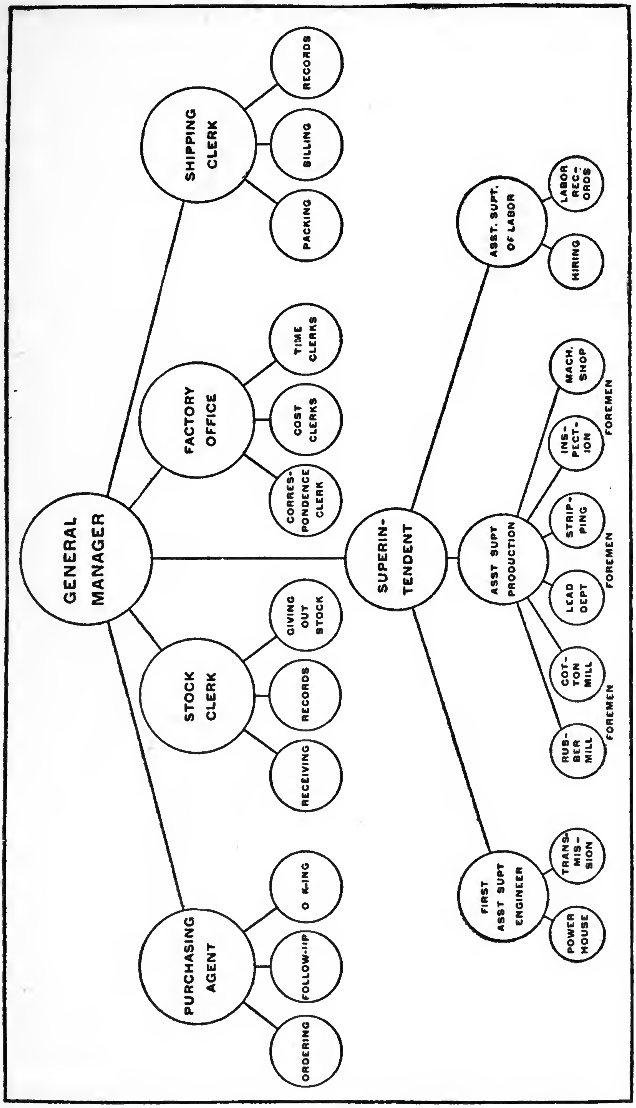


FIGURE III: Organization in the factory should be charted so as to fix department responsibility effectually. The chart shown was used in a textile mill where raw material is highly important

principles and requirements of factory conduct hold good for any plant.

Our attention is held only to those departments of the factory having strictly to do with production. At the head of production comes an official variously entitled, according to the size of the plant, factory manager, general manager, superintendent of production, superintendent of the factory.

Varied though his title, this executive's duties are clear. He is responsible for the making of the goods. In him must be combined ability to handle men, a keen knowledge of the manufacturing end of the business and executive qualities of high order. The supervisor of the rubber mill under consideration has the titles of general manager and treasurer. His position in the plant is somewhat unusual, since he not only is in close touch with the manufacturing, but also with the financial end of the business. Costs, credits, collections, purchases and manufacturing all come under his jurisdiction.

Under the manufacturing executive properly belong all the departments dealing with manufacturing, including purchasing, stock keeping, processing, factory accounting and costs and shipping. The relation of these various departments to each other and to the general manager is indicated in Figure III. Whatever the nature of your plant, you should have a chart of this sort. Posted in every department office, it fixes responsibility and shows the workman each executive to whom he must report.

When the factory responsibility has been fixed in the manner outlined the duties of each department head must be specified. A man should not be hampered in his work by restrictive measures curtailing his authority

within his own sphere, but his field of operations should be definitely circumscribed. The purchasing agent, for example, should not be hampered with an enormous amount of detail. On the other hand, he should not be a clerk but a man of some capacity who understands the requirements of the mill and combines with technical knowledge the shrewd judgment of a buyer. Railroad rates and terms must be included within his knowledge as well as a comprehensive understanding of the business.

DUTIES *of executives throughout the factory in the purchasing, stores, processing and power department, and limits of control for each department.*

As to detail work in the purchasing department, the practice varies, of course, with the work of the factory. In large plants the subdivision of the work must be carried further, but the general work of the department can be grouped under various heads.

Working data concerning quotations, prices and past purchases form a groundwork for buying. This material can often be summarized in graphical form. By such a method past practices can be very easily compared and analyzed.

Upon data so collected, purchase contracts can be made, this duty in some instances being only one actually performed by the purchasing department. Generally, however, after the orders have been made out, the duty of following them up devolves upon the purchasing department as well as approval of all invoices for materials and supplies. Quality and price have all to be considered in approving the orders.

To a simple clerical system in the organization of the stock department must be added mechanical aids to

orderliness. The duties of the stock clerk consist in keeping stock of raw material, supplies and finished product so distributed in bins as to be quickly reached and disbursed to the different departments upon requisition.

The organization of the rubber mill under consideration makes a point of having the stock rooms for raw material supplies and finished product in charge of a single stockkeeper. This places responsibility for both receiving and disbursing on one set of records and simplifies the general organization.

The stockkeeper in a mill must be thoroughly conversant with the factory requirements and should know what each department needs to carry on its work without delaying progress. If there is not stock on hand to meet the requirements of a certain order (copy of which he has received from the cost department) he makes a purchase requisition on the superintendent and the superintendent, giving his O. K. if he approves, sends the order to the purchasing agent.

Next in logical carrying on of a factory comes the organization of the processing departments. At the head of these departments, comes an executive called variously the superintendent, factory manager or production manager.

In the model plant, the sole duty of this executive should be to produce goods at nominal cost. A good many concerns are operated on the idea that the superintendent should be responsible for selling and administrative expense. This is not only illogical but leads to friction between departments.

And to secure the best results under ordinary conditions the purchasing agent should be responsible not to the superintendent but to the general manager. This

separates costs of raw material from costs of manufacture in the organization and does not engender ill feeling between the purchasing agent and the factory manager.

In the rubber mill organization, the work of the superintendent is subdivided into departments over each of which a foreman presides. The power equipment is looked after by the assistant superintendent. He, like the superintendent, is a practical rubber manufacturer, and in addition to his duties as supervisor of power, he transmits the superintendent's orders to the foreman.

The assistant superintendent must be something of a diplomat. As one foreman remarked, if the head of the manufacturing establishment studied his men as thoroughly as his costs and systems of doing work, he would get results far out of proportion to his efforts. In the small factory this personal element can be infused into the organization by the superintendent himself, but in the larger organization, the assistant superintendents and foremen can do much to facilitate the smooth running of the factory.

NEXT *in importance to the centralization of executive authority are clearly defined departmental lines with a responsible head and assistant head for each department. The business which has its factory departments so organized that each department head is responsible to the works manager, without any intervening bosses, will be far more free from internal dissensions than one in which this is not the case.*

—Hugo Diemer

Professor of Industrial Engineering, Pennsylvania State College

IV

AUTHORITY LIMITS IN CORPORATION MANAGEMENT

By Henry D. Martin
General Superintendent, The I. E. Palmer Company

NOT every factory executive need elaborate his organization and chart it on paper for his own information. His business may be so much a part of himself that he can easily follow its details; but let a new man come into the organization, and his time and salary are lost while he is trying to find himself. The relation of department to department, therefore, the range of authority of each department head, the subdivision of detail duties—each of these functions of an executive organization needs to be specifically outlined no matter what the business.

Since the textile industry embraces a wide field of manufacturing, its executive and manufacturing organization is of interest to all manufacturers. That the conditions affecting the textile industry are largely inclusive can be realized by a brief summary of the business. The making of a textile product is closely related on the one hand with the growing of the raw material, and on the other with the conditions involved in selling the goods. This is, of course, true in some degrees in all classes of manufacturing, but in textile work, the manufacturer has to consider the beginning and end of his business in great detail.

Take the weather as a single example. To be success-

ful, the cotton manufacturer must watch the cotton crop from seed time to harvest. The processor of iron and steel, wood or brass, is not directly interested in how his raw material is made. On the other hand, the fabricator of textiles must analyze weather conditions, not only because they affect greatly the quality and price of the raw material, but because they influence materially next year's orders. A retail merchant will not reorder on his stock of cotton goods if a cold wet summer cuts the sales of his stock.

The attention which the textile manufacturer must pay to his raw material is also well illustrated in the silk industry. In several instances, silk worm culture is an essential part of silk making. The making of the raw material is really a part of the manufacture of the fabric.

HOW *a chart helps to fix clearly and definitely the lines of authority among the executive officers of a textile manufacturing corporation.*

To show clearly the practical organization of such an inclusive business, the accompanying chart is helpful not only to the textile manufacturer, but the manufacturer in any line of business. The relative positions, the lines of authority of the financial, executive and manufacturing departments of a big cotton mill are graphically presented in Figure IV. In smaller plants less detail is essential, and many of the duties of the officers shown would be merged under one executive.

The diagram itself has a significant outline. The stockholders with their delegated heads of authority form the upper half of an hour-glass. The financial and executive control which they exercise is spread over the manufacturing organization through the agent who

stands between the executive and selling departments and the factory. In this position the chart illustrates the investment aspect of organization; turn the hourglass over and the diagram represents the return on the investment.

By diagramming the organization in this way, not only are the vital relations between big departments of the business displayed at once for analysis, but the dependence of one division on the other is clearly seen. With such a diagram before him, a manager can study out the best methods of handling work in his plant. The classification of vital reports is made especially easy. Starting with the top row of circles, there is represented the financial group, the stockholders. Although some may have invested more heavily and be more influential, they are all lined up and linked together as a unit. The stockholders' interest in operating focuses in a board of directors. President, treasurer, secretary and agent are elected similarly by the board and usually from the board of directors. As the assistant officers have no independent authority, they are represented by circles included within those which represent the principal executives.

Between the superior officers and the agent, the stenographer's position is shown merely as a link in the chain, not because vested authority is to be understood. The central line of the chart indicates courses of action, it shows how vital is the responsibility of the agent. The bounding line on the chart is also significant, it fixes the boundary of authority.

In the textile business, the treasurer is usually the central figure. From him radiates the directing force. While he is centrally located in one of the great cities where he can keep in touch with raw material buying,

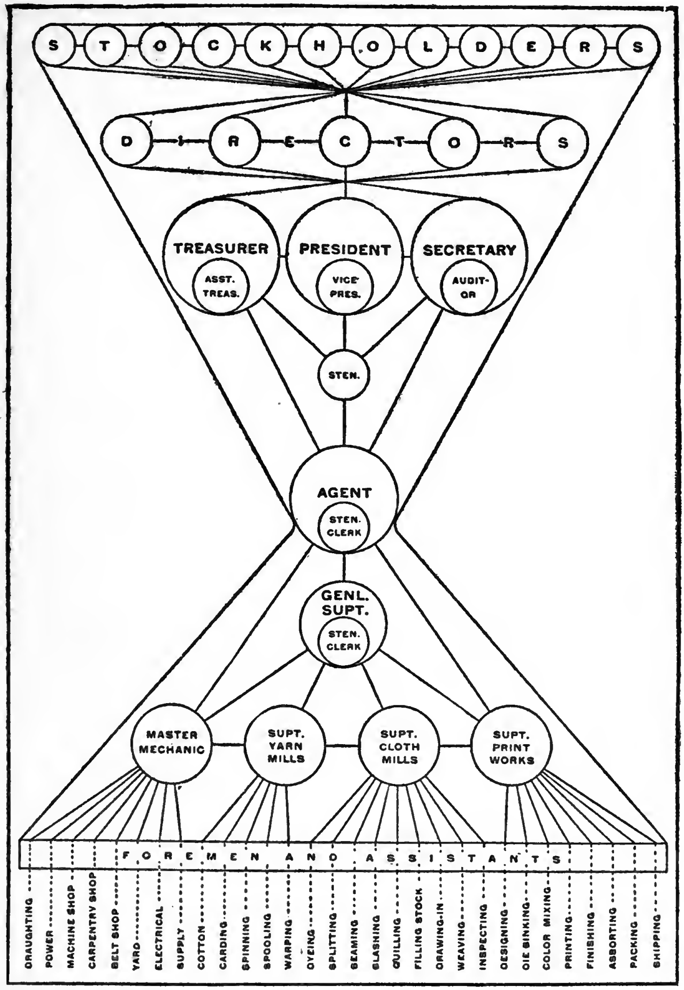


FIGURE IV: This "hour-glass" method of picturing organization was used in a cotton mill. It shows how the lines of authority from executives to operatives center in the agent

he is also in close touch with the factory, through the agent and chief clerk. In the city, too, he is in touch with the central distribution of the product. The treasurer is the balance wheel of the organization.

The president and secretary, although not always associated in the daily routine of the business, form with the treasurer a committee of conference on various matters affecting the business. At the factory the treasurer is represented by two executives, the local agent and the chief clerk. The agent is the chief representative of the company and is in charge of everything locally. The treasurer, however, may deal directly with the chief clerk about routine matters without conflicting with the agent.

The agent naturally has access to all the statistics of the business; he is the officer in chief and is so recognized. On the other hand, office detail is handled under the authority of the chief clerk, who is responsible to the treasurer, as well as to the agent.

The relation of the agent to the manufacturing, as shown in Figure IV, is that of general manager; the chief clerk keeps the record of the business. The manufacturing departments report through the superintendents to the agent. Manufacturing is divided into the mechanical, yarn, weaving of cloth, print work or general finishing departments.

These general departments are each usually governed by an executive who has the general supervision of the manufacturing. Each one of these four departments is subdivided into sections suitable and extensive enough to keep a competent overseer sufficiently occupied to make it profitable for the company. This method of subdividing the work of the main business under responsible heads is applicable in any business.

A competent man may be given one or more departments, divisions or sections, according to his strength or capacity. However, an overseer is rarely given a group of sections or divisions that are not closely related. If he has several divisions, they are usually of the same process, or of processes closely related that succeed one another.

Each overseer has an assistant and together with these assistants these men constitute the great link in the chain of organization which comes into close contact with the men who actually perform the work of carding, spinning, weaving, together with all its preparatory and finishing details, and who must produce the goods wanted by the skilful touch and work of their own hands.

Like the foremen in other lines of work, the men at the head of these detail departments must be responsible for the accomplishment of the work. In their choice rests a great deal of the success of the men above them. However much their supervisors, all the way up to the president, may know of the business, and no matter how well they can perform the work themselves, their chief employment is to supervise—plan, govern, and produce the goods through the men who are paid to manipulate the stock and guide it through the intricate and expensive machinery operated for the purpose.

LINES *of executive authority which link each officer of a corporation with every other, place responsibilities and insure the correct processing of work.*

Starting with the agent again, it will be noticed that the lines of authority are evenly distributed, descending into the midst of the work where the foundation of the manufacturing starts. The agent gives the general

superintendent entire charge of the manufacturing; all orders pass through him to the departmental superintendents of the yarn and cloth mills. The same rule is adhered to between the departmental superintendents and their overseers.

All of the departmental superintendents, as the chart indicates, have coordinate authority. Ncne has higher rank than the other, and all closely cooperate. Likewise, the overseers, although they belong to different departments and report to different heads, are logically bound closely together in the general organization.

In detail the chart presented brings out points which ought to be emphasized in every manufacturing plant. Coordination of work is the policy of this entire organization. All executives are linked together. Knowing his duties, each man is absorbed in securing a proper organization, and with that end in view, his energy is focused on the point represented where the lines from each man meet. This is true for both financial and manufacturing divisions of the business. It is even more important in handling the clerical work. The central line, that of authority, is the line of action—the boundary line is a "compact" line that binds the departments together. The boundary line also shows the limit of authority in each particular case. In other words, a company's business is the business of the company, not of the individuals composing it.

Moreover this line emphasizes another need of organization—an observation line. Although the orders from authority are handled by different departments, it is the follow-up line of the organization.

At first glance the double lines of authority in the textile mill organization may seem confusing. The ideal would be a single line, no doubt, but this chart repre-

sents practical working conditions and under these conditions the agent's authority is more flexible.

The agent gives the orders in some cases direct to the master mechanic and to the superintendent of print work. Oftentimes there is no general superintendent, but in the organization outlined, the general superintendent has executive control over the departments specified. Because of the agent's connection with matters outside the factory—the water works and houses—his relation to the master mechanic is as indicated in the figure.

Because the print works is the last in the chain of manufacture and therefore in close touch with the sales end of the business, the agent's connection with it is logical.

INDUSTRIAL *organization has outgrown the one-man stage. Business is too big, interests are too varied; one man cannot do or give enough to contain a whole business in himself. The corporation—which signifies the resources, the brains, the work of many men merged for one purpose—is now the business unit.*

—Clarence M. Woolley

President, American Radiator Company

V

HOW TO KEEP TAB ON EACH DAY'S WORK

Based on Interviews With Six Factory Managers

EXECUTIVES' time is important. Minor details which the private secretary or department head can handle as well as the general manager should not be allowed to consume the valuable minutes of the latter. A thousand and one things come up in the routine of business, and the fear that these problems will be incorrectly dealt with must not constantly haunt the man at the head of a large business. He must be free to take hold of the really important questions, the vital things that affect the fundamental policies of his business. His mind must not be a jumble of heterogeneous, unrelated facts. He must be able to shove off the petty responsibilities and attack the big problems with all the energy he is master of.

Nevertheless, he must hold the reins on all departments. He must have some plan which quickly and surely puts him in touch with the manner in which his subordinates are working, and shows him at once the tendencies which make for success or failure and assures him of being in fact the guiding and controlling spirit of his business.

The simpler the plan which the executive devises to secure this control, the more effective it is likely to be. Sweep aside the unessential detail, and go at once to the

heart of the question. It may be a matter of twenty thousand dollars or a hundred thousand, and yet not require the attention of anyone but a clerk. On the other hand, it may be a seemingly trivial affair, yet if the wrong decision means heavy continued loss of profit, that is a matter for your consideration.

Following are the plans used by different factory executives to keep track of what is going on under them. One of them will meet the needs of your business also, or suggest methods for your own procedure.

TO HAVE ***reports put in writing, S. D. Rider, vice-president of the South Bend Watch Company finds, enables him to make his decisions clean-cut.***

The vice-president of the South Bend Watch Company demands written reports always. He says: It has been my experience that there is not any method of watching one's business that will apply to all situations and conditions. In our own case I receive daily written reports of orders taken, shipments made, finished production, and cash receipts and disbursements. I receive weekly written reports showing the progress of our production through the factory, and in addition to this have weekly conferences with the heads of some departments, in order to determine ways and means of facilitating the production or sale of goods.

Written reports are, of course, the basis from which we can direct our efforts in working toward the improvement of our business. Personally I do not believe in verbal reports and never accept them except in rare instances. There are two reasons for this. The principal reason is that the party or head of the department making the report is apt to over or underestimate the actual conditions, and there is also the possibility that

if this fact is taken up with him at a later date he will forget just what statement he did make. Written reports make these conditions impossible.

I also believe that after a man has made a written report or an estimate of what he expects to accomplish that he is going to put forth greater effort in order to bring about the estimated result. I am also of the opinion that the giving of verbal reports is apt to load all of the responsibility on the chief executive and this, I believe, would be entirely wrong. In order to accomplish the best results it is necessary for every one in the organization to realize that his work and his position are just as important as that of any other person, and his responsibility just as great as that of any other person in the organization.

BY *departmentizing his production reports, Roger Keith, assistant treasurer of the Brockton Webbing Company, quickly gets the story of work in his factory.*

The assistant treasurer of the Brockton Webbing Company gets his story in seven reports. He says: Our plant is comparatively small and we need no elaborate system. Foreman's reports, however, handed in to the superintendent at regular intervals, keep us in close touch with everything that is going on in the factory.

Our mill is devoted exclusively to the manufacture of narrow cotton fabrics. The system used and its reports and the relations they bear to the general office, the mill office and each other is quite simple. The measurer turns in daily to the mill office a report showing only the irregularities of any nature, such as a shortage in the number of pieces, and so on. He also makes a report daily to the general office showing the amount and the kind measured, but making no special note of irregu-

larities. From the measurer, in addition to this report, there comes to the mill office at least once each week, or oftener if called for, a small sample of goods from each loom. These are turned over to the designing record of the "picks" and "ends" in each piece, returning those that are not correct to the mill office.

The floorman's report is given by the man who takes off the work and shows irregularities noted by him, such as the running out of a warp, and goes only to the mill office. This report should prove up with the measurer's report. As these reports give only irregularities, it is not necessary for the mill office to waste any time. Attention may be focused at once on the proper loom.

The same is true of a report which is along the same lines and comes from the designing department twice a day. A man from this department makes a trip among the looms and hands in a report showing irregularities in length, width, and so on. A duplicate report goes to the loom fixer of each section and he at once endeavors to correct errors. A good result of this particular report is that the loom fixer, knowing that it is going to the mill office twice a day, strives to do his best to have a "clean sheet" turned in for his loom section. A report from this department also goes to the general office showing the changes in patterns. The foregoing reports pick out the flaws and bother in no way the work that is going along normally.

Reports come also from the yarn department, under which department is included the baled yarn, the winding and the warping. The first of these is a weekly report, and shows the amount of work done by the warpers (girls on time pay). It gives the time spent at their machine and the machine's output and a detailed description of the work they are turning out, with length,

color, number of ends, size of yarn, and so on. There is also a chance for remarks, giving the girl the opportunity of explaining any deficiency. These reports are individual ones which girls keep themselves under the supervision of the foreman who is responsible for their transmission to the mill office. The second of these yarn department reports is the foreman's weekly report showing the amount of unwound yarn on hand, giving size, ply and color. A duplicate of this goes to the general office for use in the ordering of the yarn.

An "irregularity" report showing the bad work made by the mill in sum total and that made by each individual weaver is sent to the mill office. This is one of the most important factors because at the present time in several states you must pay for all work turned out by the weavers. One can not now either deduct for poor work or fine for bad work. As the weaver's natural desire is to turn out quantity, not quality, we watch this department closely, and our reports enable us to determine the value to us of one weaver over another. This report is a weekly one, but is kept in such a way as to be available daily if so desired.

The loom fixers send a report to the mill office every month which shows the use of new parts on the looms. Looms have hundreds of parts, and it is essential that we keep a record of the wear and tear of certain parts. By so doing we are able to tell the frequency of renewal and the average. An account also can be kept of the number of breaks on one loom as compared with that on another and the mill office can make its own deductions as to whether it should be charged to carelessness on the weaver's part or to the age and depreciation of the loom.

With the above seven reports, the mill office, and to

a certain extent the general office, is kept in touch with the workings of the mill. At the same time, however, we do not neglect personal supervision, which is a necessary and important factor in the smooth working of an organization.

THE *belief of E. Howard Reed, superintendent of the Reed & Prince Manufacturing Company, is in personal contact with his men rather than in reports.*

In a similar connection, E. Howard Reed says: We make some use of detailed reports, but do not believe these are of much value when they contain details too minute to be given proper attention. In other words, with a given amount of time it is impossible to go into detail beyond a point which is hard to define and yet which already exists.

We have a monthly meeting of department foremen for a general discussion of such items as are of interest to all or most of the manufacturing departments. This meeting is supplemented by following up various lines through the factory from month to month, and keeping in personal touch with conditions.

Personal contact with conditions as they are rather than with theory of what they should be is perhaps the vital point in the whole matter of keeping in touch with the factory.

THE *superintendent of the Chicago factory of the Federal Sign System (Electric), L. G. Shepard, secures control by both reports and personal supervision.*

L. G. Shepard keeps close watch on delayed material. He says: There is a foreman at the head of each department who keeps the orders upon which he is working at his desk. I make it a point to go through the fac-

tory as often as possible and it is by taking up the orders in the several departments with the foremen that the master mechanic, his assistants and I get in closest touch with the work.

In addition to this system I have every foreman make out what we call a "delayed order form" when any order is held in his department for any reason whatever. This form is a notification to me of the trouble and I send it to the purchasing agent, stock clerk or other persons as a notification to hurry along the material that is holding up the order.

In addition to making an extra effort on this particular material, this person or department makes a notation of the probable length of delay and sends the form to the order department where the shop orders are originally made out and who are supposed to keep in touch with the progress of the orders through the factory by sending a man from their department to the different foremen regularly. The order department uses this form to notify the customers of the unexpected delay.

The billing department gives me a report daily of the amount of material shipped by the factory. I am also in touch with a report of business contracted, and, therefore, I am advised daily in round figures of the amount of business in process.

REPORTS *which show the exact state of orders keep Robert F. Schmidt, Superintendent of the Office Specialty Manufacturing Company, in touch with work.*

Robert F. Schmidt says: In our system each department sends to the office a daily report of the orders it has closed and forwarded to other departments. Every order is entered before being sent out to the factory, and so by having the necessary columns on the right

side of the entry sheets it is a simple matter to put in the date that the order has left the department. This not only gives us a check when the orders leave the departments, but also gives us the time that this order has been held in the different departments. Therefore, when we receive any inquiries as to how soon we can complete an order, we simply look up the sheets, ascertaining in what department the order is held and if it is near the finishing and enameling room we can then give a promise without getting it from the factory.

This applies to all orders whether in stock or special, and although we are handling over a thousand orders a month we have found that this method is very simple and helpful. But as we have both a metal and wood factory, we enter on the sheets all the metal orders in red and all the wood in black, so that when an inquiry comes in we can tell in a minute whether it is a wood or metal order. As soon as our order department receives the output forms from the shipping departments it is recorded in our office and entered on the sheets as being shipped, giving the date. It is a very simple method and it does not require any skillful help. We have found it the most useful record we have in the factory.

CONDENSED *reports which have no unnecessary details keep the office manager of a button factory in perspective upon the big facts of his business.*

The office manager of a button factory does not believe the executive should be burdened too heavily with detailed reports in which he is liable not to see at a glance the point of most vital importance. He says: Our experience in keeping the chief executive in touch with the factory has been that it is not advisable to provide

the executive with a large mass of detail figures in the form of periodical reports. The chief executive of any business is usually too busy to take time to draw proper conclusions from these figures, even though they may be of value and interest.

We prepare for our chief executive a condensed report which enables him to gauge successfully the operations of our business. This report gives the following information: The increase or decrease of merchandise in the factory for the preceding month in six divisions ranging from raw material to finished product. The report does not show the amount on hand, but shows where there has been an increase or decrease in each division in both quantity and value.

The report gives this information not only for the preceding month, but gives information showing the increase or decrease since the beginning of the fiscal year. The increase or decrease in these six divisions is totaled to show the entire increase or decrease of merchandise for the period.

From this report the executive is able to tell whether the factory is tying up more or less capital and in what divisions. If further information is desired the cost department is prepared to furnish detail information which can be taken up with the superintendent of the division concerned.

The report shows the increase or decrease in cash on hand, accounts receivable and other miscellaneous liabilities, the estimated amount of profit for the month and from the beginning of the fiscal year, the amount of sales for the month and from the beginning of the fiscal year, compared also with the corresponding period for the previous year. All this information is given on a single sheet measuring four by six inches.

It can readily be seen that with this information placed on the executive's desk by the tenth of the following month he is able to tell at a glance just what the business is doing. Detailed reports on any one subject can be supplied if he wishes them, but these few and simple reports give him in concise form the big general outlines of the efficiency of the operating departments, the progress of the sales department, and the net result in amount of profit.

THE *management of the large corporation is to do for industry what the inventor has done with machinery; for, after all, a machine is simply organized thought, and while no patents are granted for improvements in management, there are just as real inventions in the field of organization and management as in the field of mechanic arts.*

—James Logan

Chairman Executive Board, United States Envelope Company

VI

HOW SCIENTIFIC MANAGEMENT IS APPLIED

By Neil M. Clark

EVER since the rise of factory production, the contest between employer and employee has been growing more marked. Employers have tended to exact a bigger day's work from employees, employees have steadily resisted. Against the silent perseverance of laborers, tactless attempts on the part of manufacturers to secure bigger results from the human element in the factory have been of little avail. Mechanical genius can devise new methods of speeding up machines and increasing their output; but men have the wit and frequently the will which enables them to avoid giving their employer a full day's work.

The failure to secure maximum efficiency from men has been primarily due to the lack of knowledge on the part of managers as to what constitutes a full day's work. Their employees, naturally, are not eager to tell them, when so doing means simply an increase in the amount of work demanded without an adequate increase in wages.

The tendency of day wages, at least under ordinary conditions, is to make all men work at the same rate, usually at the rate of the slowest man instead of the fastest. Paying what the labor is worth regardless of the individual performance of the laborer has been a

prevalent fault. Shoveling dirt from a ditch for ten hours has seemed to be worth two dollars. And that is the rate at which every trench digger works, whether he lifts six tons of dirt a day or nine.

CUTTING *hastily set piece rates is often the cause of hostility on the part of employees; the scientific manager works on the basis of accurate knowledge.*

Under haphazard management there is no distinction between the worker who is naturally fast and the man who habitually lags behind. And it is only natural that in a large gang of laborers governed by no spirit of competition, where each man receives exactly the same pay as every other man, the slow worker sets the pace. What incentive is there for the man who can easily shovel nine tons of dirt in a day to tire himself out, when he receives no more pay or praise than the man who shovels only six?

Realizing that the full day's work was not being given, many managers attempted to secure it by putting men on piece work instead of day work. At once output began to increase, and workmen extended themselves to the limit in order to win the greater rewards thus promised them. Men who had earned $2.50 a day before, began to make double and even triple that amount, and their employers immediately saw the reserves of effort which they had failed to draw on.

Unwisely, after the initial mistake of setting inaccurate piece work rates, employers began to cut these rates; so that the laborer had to work faster than ever before to assure himself of receiving his former wages. The unwisdom of hastily set piece rates which are frequently cut has had much to do with alienating employee from employer and is the cause—perhaps more than any other

one thing—of the hostility with which workmen of to-day view every attempt to gear up their productive efforts to a higher speed.

Accurate knowledge of the right way of doing things and the right time they should be done in, careful study to find the "one best" way, is what differentiates the concern governed by principles of scientific management from systematized or unsystematized organizations. Thousands of stop-watch observations are made before a single standard is set. Each operation is carefully analyzed into its component operations, and those which are necessary are kept; those which are unnecessary, eliminated. Tabulation, analysis, comparison—all enter into the program of the scientific manager, exactly as they enter into the researches of the chemist or physicist. And like the scientist, also, the student of improved management constantly seeks to evolve from his mass of observations general laws which will aid him in future investigations.

Lower labor cost with higher individual wages is his purpose; and the method of procedure is that of the laboratory expert. He seeks to be perfectly open-minded and fair-minded. Wherever there may be waste, his eyes are open to perceive it; and having seen it, he is not blinded by the near view of his problems, refusing to install and enforce the up-to-date, "one best" method.

The primary thing to acquire, then, in approaching the problem of better management is the scientific attitude of mind which bends itself to the probing of every operation and circumstance, and establishes the scientific method for each performance. The one, and perhaps only, indispensable mechanical requisite in this system is the stop-watch. The leaders in scientific management have again and again sounded warnings against

adopting merely the hollow shell of the thing, and failing to catch its essential spirit.

Specialization, so distinctive a feature in modern industrial organization, reaches its highest application in the theory and practice of scientific management. It reveals itself first in the broad division of all work into the two fields of planning and doing, considering these functions as essentially opposite in nature, to be performed (for the attainment of highest efficiency) by different individuals. This first broad aspect of specialization indicates the nature of the second, which takes its place in the organization as the division of functions into staff duties. In place of the single foreman who is responsible for all matters concerning orders, men, materials and machines in his department, scientific management substitutes a number of "functional bosses," each of whom is a specialist in one line. The old idea of the slave-driving foreman disappears. In its place comes the newer, more scientific idea of helping, training and inspiring the workman.

SCIENTIFIC *management separates planning from doing, sets standards, trains and rewards the workman—how the "functional foremen" operate.*

The program of scientific management resolves itself into a number of specific problems. Standardizing conditions and operations by thorough investigation; planning work on the basis of these standards; selecting fit workmen and training them in the performance of the "one best" way; providing adequate compensation for their increased output; making the system self-perpetuating—these are the fundamental things to do if you seek to manage scientifically.

In the first place, every operation is to be investigated

thoroughly, waste movements and unnecessary effort eliminated and the final result set as the standard. The stop-watch guides the investigator in this work. But he must also standardize conditions. There may be a "one best" way, and a standard time, for carrying pig iron from a pile and loading a car one hundred feet distant. It may, however, be possible by the simple expedient of changing the place of the car or the pile of pig, greatly to change conditions and labor cost from the first standard.

Once the standard times and conditions have been established, it becomes the duty of the planning department to analyze orders, and furnish workmen specific jobs, with each necessary operation plainly written out so that it is impossible to mistake it. This department also sees that instructions are forwarded to the stock room and tool room so that no delay need be caused at the machine because materials have run out or tools are not on hand. When the workman receives the instruction card, men are ready to explain details of the operation which he does not understand—trainers, who show him exactly what to do and how to do it. There is another man who repairs his machine if it breaks, but whose chief duty is to see that it is in perfect condition all the time. Another man regulates the speed of the machine; and, as other functions and duties appear in different organizations, scientific management provides functional specialists to perform them.

The incentive offered the operative varies in different kinds of work and with different classes of workers. It may be a simple piece rate, a differential piece rate, a task and bonus method of payment—any one of a number of payment plans may be adopted to arouse the worker's enthusiasm. The point not to lose sight of,

however, is that the purpose of any incentive is to induce the workman to perform his task in the "one best" way and in the standard time.

To be self-perpetuating, the organization must draw its leaders from the ranks of its workmen. Men who have reached the standard rate of efficiency as operatives, who are known as capable and reliable men, should be selected as investigators and functional bosses with the path open ahead of them to higher positions as fast as they show the ability. Thus, beyond the mere incentive of the day's wages, there is the call of ambition and the possibility of a better future open to thorough workmen.

In a way, scientific management has made the operative the driving force of the factory. Trained investigators are there to help him find his own highest efficiency. Foremen, one and all, and the entire planning department, work to keep him supplied with tasks. Messenger boys run to the stock room to find materials when he requires them, or to bring tools to meet his needs. Other laborers carry away his finished product; and as soon as the last stroke of work is done on one piece of work, another job is furnished him, carefully planned and thought out. The speed boss is also at hand to determine the proper speed the machine shall run at, the repair boss to see that the machine is in fit condition. In short, the operative operates; the planning department plans, the foreman exercises authority in the one field in which he is a specialist.

There is joy in work accomplished to the full of a man's ability, and for the laborer it is mentally and morally stimulating to do his best. Wheeling dirt from seven to six is, under ordinary conditions, as soul-deadening as any work in the world. Introduce into it a

spirit of competition, give the workman a task to accomplish, an incentive to do his best, and having established scientifically what "the best" is, your work will go forward in greater volume than ever before. The workman, moreover, usually finds himself happier.

Accurate knowledge did away with the superstitions and vague beliefs that clung to natural sciences in the middle ages. Accurate knowledge in the shop is the chief opponent of deceit and inefficiency in factory work and factory administration.

THE *development of any manufacturing business today and the plans for growth in any factory hinge on this one idea—specialization. In practically all lines of work—machine shops, shoe factories, textile mills, woodworking plants—the way to get more and better work done, is to cut one job up into little jobs; make one man responsible for that one little part. Two ends are gained by this method of manufacture—greater production per man, with consequent lower costs and accuracy.*

—E. H. Ahara

General Superintendent, Dodge Manufacturing Company

PART II—BUILDING AND EQUIPPING THE PLANT

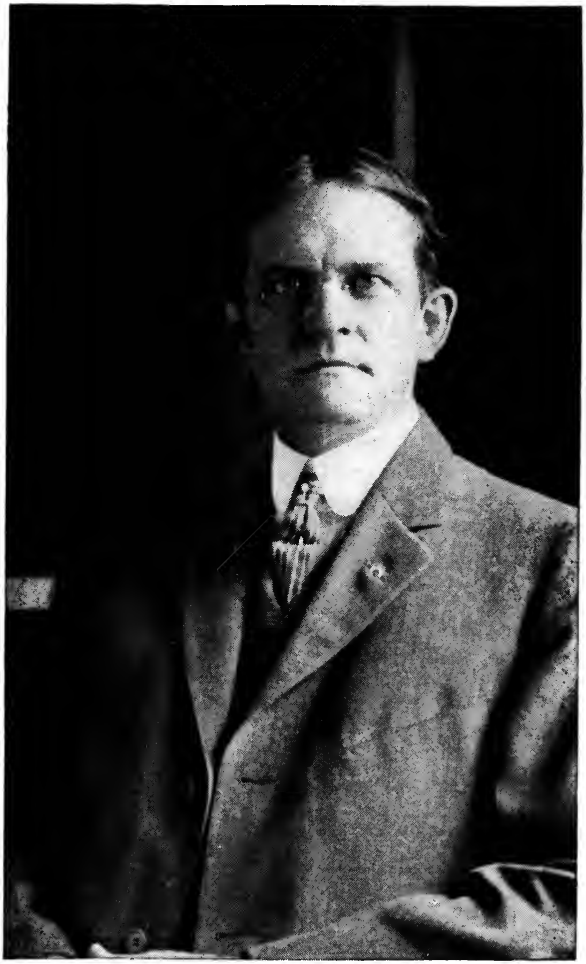
Delegate Details

ANALYZE the career of the successful business manager and you will find that he has done two things: by elimination and selection he has fitted competent men to the places at which the work focuses; by system he has so shifted detail to the shoulders of subordinates, as still to keep the essential facts under his own hand.

This pyramid of subordinate authority keeps him above the routine and in command, giving him the freedom necessary to decide policies and to plan ahead. His daily production reports are a sure barometer of efficient and effective operation. When work goes wrong he knows where and at once reaches the man responsible.

The young executive, ambitious to do the whole day's work himself, often neglects to delegate detail and responsibility to the proper subordinates, and so is crushed by his load. No man's place is more than a stone in the pyramid. Success in factory organization lies in the selection of competent helpers and their realization of responsibility combined with judicious latitude of authority.

The secret of successful management may be summed up as follows: Organize, Deputize and Supervise.



WILLIAM A. FIELD

Superintendent, Illinois Steel Company, South Works

VII

WHAT TO GET IN A FACTORY SITE

By Hugo Diemer
Professor of Industrial Engineering, Pennsylvania State College

FACTORY location is a problem which presents two general aspects: first, the choice of a town or city, and second, the site within the town or city. Location means everything to a retail establishment. As a rule it means less to the factory; yet its real importance is often overlooked. A well managed factory may fail in a poor location while a poorly managed one often owes its very existence to the location.

The selection of a town or city for a factory site is influenced by considerations regarding: (1) raw material, (2) labor, (3) transportation, (4) market, and (5) money outlay.

So far as the cost of raw material is concerned, that location will be the best which will make total resultant freight charges of all raw materials the minimum. As a simple example, take the case of an establishment manufacturing paving brick. It has been estimated that the relative weights of clay, finished product, and coal required in this industry are approximately as 40, 30 and 3, respectively. In a case of this sort it is evident that in choosing a site near coal fields, clay beds, or distributing centers, the most advantageous point would be next to the clay beds. Of course, the combination of several favorably influencing conditions will be more

desirable, such as clay beds with cheap fuel close at hand. Such conditions exist in natural gas fields in several sections of the country.

From the standpoint of ease of securing satisfactory labor, the city presents a far more advantageous labor market than a town or country site.

RIGHT *location requires that the factory be near labor supplies and transportation, and convenient to the most important sources of its raw materials.*

Skilled labor is most easily obtained on short notice in a city. In the country town labor is cheaper, and the workmen are likely to be more contented. They are likely to marry and have homes in pleasant surroundings, and the inducements for wasting their earnings are not so great as in the city. At the same time the country factory is expected to exercise a paternal interest in the employees and town—a responsibility from which the city factory is relieved.

A suburban site, convenient to a belt railway such as exists in most of the larger trade centers, presents many advantages over either city or country. It permits the purchase of sufficient ground for a factory site to allow for future expansion. It has the labor market of the city to draw from and offers the workmen who choose to live close at hand, the opportunity of pleasant home sites.

The cost of transportation of both raw material and finished products is a factor of vital importance to the manufacturer who is at the mercy of a single railroad. It is very desirable to have a location which affords a choice of several routes or possibly a choice between railway or waterway. Water transportation has the advantage of cheapness, whereas the railroad is faster.

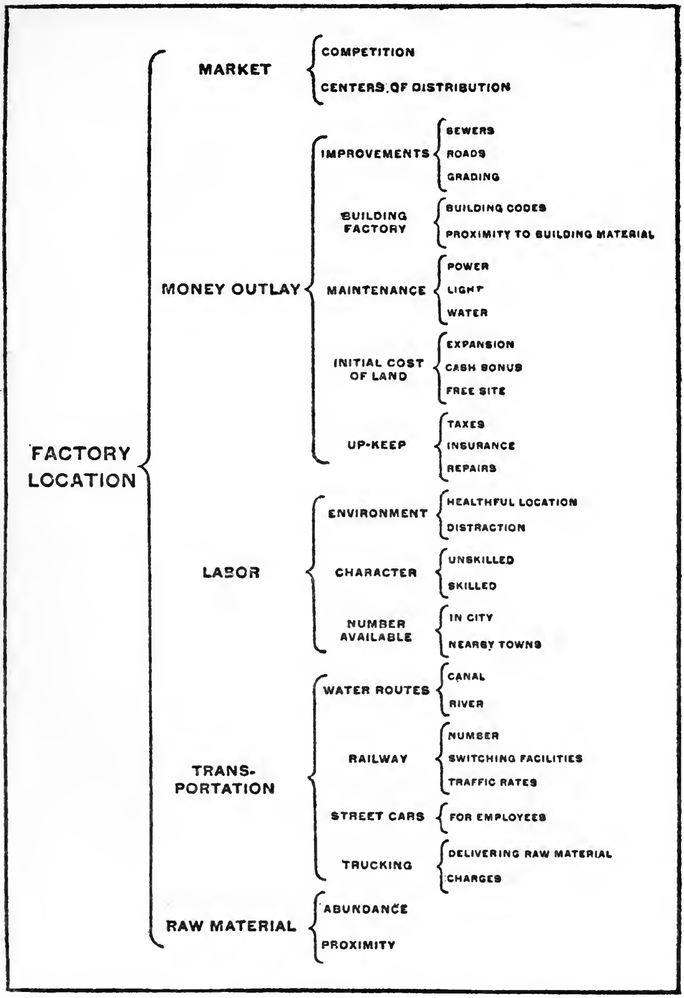


FIGURE V: Practically all considerations affecting the location of the factory are shown in this chart. Before choosing a site, every one of the points noted should carefully be studied

A factory whose product is bulky and does not suffer from slight moisture, would be advantageously located on a waterway. The greater expense of railroad transportation is largely due to the high speed demanded for passenger traffic. A system of freight railways especially arranged for heavy tonnage and moderately slow speeds would be of great advantage to the economic distribution of factory products.

A location conveniently situated for the receipt of raw material by way of the cheaper waterways, and at the meeting of railways, makes an extremely favorable location. Examples of manufacturing centers so located are Pittsburg, Buffalo, Cincinnati, Cleveland, Milwaukee, Chicago and St. Louis.

In the case of light machinery, or of any output in which the labor is considerably greater than that of materials, nearness to raw materials is of minor importance. The larger cities are always the best places to secure skilled labor, and they offer also prompt shipping facilities for manufactured products, and a sales market close at hand. Industries of this sort are naturally most numerous in the larger cities of the country, such as New York, Philadelphia, Boston, Chicago, and so on.

Numerous smaller cities will answer many of the requirements for the most economic factory location. While the history of the past seems to point towards the large city as the most favored factory site, there are many examples of success in smaller places. The labor agitator finds the small town a poor field. Pleasant surroundings and sunshine tend toward contentment—the worst enemy of the walking delegate.

With reference to nearness to the selling market, it is evident that the factory should be at the point from which it can ship with equal promptness and cheapness

to each of its principal sales centers. The location of many factories in surroundings not at all favorable to cheapness of production has been due to the fact that their founders, realizing the local demand, started the establishment in the best sales market.

The oldest manufacturing establishments of the country have been located chiefly in distributing centers, where commodities are easily exchanged. In addition to the advantage from a selling standpoint such centers present the advantage of abundant labor. The convergence of railroads in larger centers of this sort also offers facilities for promptly securing raw materials.

Advantages of direct contact with the consumer offered by a factory located in the large city are worth careful consideration. Frequently, after the removal of a factory which has found its city site disadvantageous as compared with a location in the suburbs or the country, some new-comer has been able to start a thriving establishment near the old site, with perhaps less profits, but still reaping advantage from his nearness to markets.

The cities that form the best sales markets are those where trade routes meet. Similarly, good sales markets are afforded by cities at the convergence of navigable rivers, such as Pittsburg and St. Louis, or at points where the limits in navigation necessitate transshipment, such as Chicago, Cleveland and Cincinnati.

Another class of cities forming good markets is found at collecting and distributing points in exceedingly productive regions, such as Indianapolis and Kansas City.

In cases where the factory need not consider itself merely an adjunct to the sales department, consideration as to cheapest site, cheapest transportation of raw material and finished product, and good labor markets should determine the location.

The question of money layout is frequently one on which too much stress is laid. It frequently happens that enterprising citizens in a small town are willing to furnish a free site. They may even go so far as to raise the cash bonus usually obtained by the sale of building lots in the vicinity of the proposed factory site. Such inducements may often be based upon sound logic and may result in good to all concerned. There have been cases, however, where with even such advantages the factory has failed and the enterprising citizens have lost money invested in town lots because insufficient consideration had been given to more important factors.

FACTORS *to be considered in choosing the right location in town or country—first price of land does not always insure getting the cheapest site.*

Many sources of information are open to the man who is seeking the right factory site. Railways frequently have an industrial agent whose sole duty it is to investigate advantageous locations; and where the absolute reliability of such information is assured, it is a big help.

Having found the right town or city, the manufacturer must next consider picking out the one best factory site in that town.

At first thought it would seem essential for a factory using heavy raw material which has to be shipped from some distance, to be located on a railroad track; yet the majority of these factories are, in actual practice, located away from railroad tracks. The small establishment thrives best near the great buying centers. These are usually away from the railroad, and nearer a good supply of labor.

There is also often an advantage in being located in

a center where certain classes of manufacturing already prevail. For instance, a clothing shop would probably be out of place in a center devoted to the manufacture of machine tools.

In changing locations in a given city, get positive information concerning the cost of trucking to your various city customers, learn whether there will be extra drayage charges from your local suppliers to the new site, and find out the exact drayage or switching charges to the various railroads from the new site as compared with your present location.

The factory site on a waterway without railroad facilities is of little advantage nowadays. On the other hand, a location accessible to both water and railroad is particularly desirable. The wonderful manufacturing development in such cities as Detroit, Cleveland and Buffalo is evidence of this. Such a location is especially desirable for industries using bulky raw materials such as timber and iron ore. The waterway serves these raw materials with low transportation charges and a railway is convenient for shipping out finished products.

In choosing between two railroads, the class of raw material carried by one may favor a site along its tracks, even though outward shipping facilities on it are not so good as those of the other. For instance, a company making sewer pipe or fire brick would probably prefer a location on a road passing through the fields from which it draws its raw material even though that road might not be able to handle outgoing shipments as well as another.

Nearness to a general labor market also may lose its attraction if another site is near a specialized labor market. For instance, there is a constantly increasing trend of machine tool builders toward the Mill Creek

Valley settlement of machine tool shops in Cincinnati. Even in the specialized centers, however, another factor needs to be considered; namely, nearness to the working man's home. Other things being equal, the working men prefer to work in a shop to which they can walk or to which the street car trip is shortest; hence it is often important to find out where the majority of your class of workers live.

Nearness to the sales center of a city may be important if this encourages personal visits from buyers. Many jewelry and other small manufacturing businesses in large cities have especially to consider this point.

In buying land on the outskirts of a city, adequate supplies of water, light and power, and easy street railway transportation are all essential factors.

The busy manufacturing plant located where many people can see it has a decided advertising value. A number of successful automobile concerns have for this very reason located on roads which are favorite driveways.

All these factors must be considered with great care by the man who is selecting or changing his location. Failure to consider a single one of them may mean the margin between low or high cost of production, between ultimate success or failure.

FREQUENTLY *it pays, as a matter of cold, hard figures, to scrap an old plant entire, and build and equip a new one, merely to take advantage of the improvements in equipment and to gain the most efficient routing of production.*

—D. R. Swinton

Of The Nordberg Manufacturing Company

VIII

PLANNING AHEAD IN SHOP CONSTRUCTION

By Henry T. Noyes, Jr.
Secretary, The German-American Button Company

MANY factors enter into the planning of a new manufacturing plant. Location, arrangement and construction have, however, principal consideration, and each will have a definite relation to the whole plant as an efficient unit of production. Each of these principal considerations has, of course, its modifying aspects. For example, in addition to the cost of the land it is necessary to consider its accessibility for employees, space for expansion, transportation facilities, nature of the soil, and the amount of grading necessary.

Before we planned our new factory buildings we visited a great many plants in this country, studied type construction and the conditions affecting manufacture in each case. While there are industries that require plants suited to their particular business, in other industries a general type of building is satisfactory for all. In this second class come most light manufacturing concerns and, having reached this conclusion, we can say that our buildings were really designed in the main not for the button business, but for general light manufacturing. We do indeed require in one building or part of a building some special construction for our business, but the remaining space in the plant would be equally suitable for any other light manufacturing business. The United

Shoe Machinery Company, for illustration, has one or two special buildings, but in our opinion both they and we could in general, interchange buildings without operating disadvantageously. Shoe factories, clothing factories and similar classes of industries could utilize our buildings as efficiently as we can. In most light manufacturing, good air and light are very desirable. So we felt from the start that a location was demanded where light and air were not restricted by surrounding buildings.

ACCESSIBILITY *to employees is an important point to consider in locating your factory—also the possibility of readily selling in case of need.*

One of the most important things to consider in locating a plant is its accessibility to employees. Our location is very central. We are actually less than two-thirds of a mile from the center of population of Rochester and we adjoin the public market and the state arsenal property. If growth of the city continues for twenty-five years in the direction that it has in the past, our property will be the center of population. We are near five street car lines.

In considering the accessibility of a factory from the standpoint of the location of employees' homes, the class of labor employed must be taken into consideration. A distinction can be made between factories which employ skilled labor and those in which young men and women make up the largest percentage of the payroll. In the first instance the factory can safely be located on the outskirts of a city, but in the second case to do so might involve great loss. We found instances in which different plants in the same city were paying for girls a difference in wages of $1.00 per week due solely to ac-

cessibility. When employees have to pay sixty cents a week for street car fare and have to take or buy their lunches, they expect to get paid for it.

Valuable people do not like to waste thirty or forty minutes going to work and the same time going home. They give preference to a business which can be reached within five or seven minutes' walking. An accessible location, therefore, gives you help at a lower wage and gives you the pick of the best help. We have at present over eight hundred people in our employ. Figure that five hundred of them are affected by the above argument.

The advantage of our location as against one on the outskirts of the city may be presented at $1.00 per person per week, say, $50 a year for five hundred people, or a matter of $25,000 per annum. From this standpoint we felt justified in paying a high price for our location, and we believe that many factories make a mistake in going into the suburbs where land is cheap, without taking into consideration the labor problems. Of course land at the outskirts of the city will increase proportionately more in value than ours, but ours will never be worth less and will increase gradually.

As we have located our factory, therefore, we are at the apex of a wedge of fine residences that penetrates into the laboring section so that we draw labor from three of the four points of the compass. We estimate that there are 40,000 people within walking distance of our plant, and nearer to our plant than any other factory employing the same class of help.

Another point that we felt worthy of consideration and which had influence was the future value of the "salability" of the plant. In this connection three points are of moment:

First, a plant to be readily salable must be located on a railroad track. Even if a concern has little use for railroad facilities, it will not pay as much for a plant remote from a track as for one so located. We are located on the main line of the New York Central Railroad and have a side track of our own.

Second, the layout and arrangement should be suitable for any light manufacturing business. A general plan should be in mind rather than one emphasizing some particular need.

Third, this last argument should have influence in the design and the construction of the building. For illustration in making calculations for floor loads this salability viewpoint is entitled to consideration, especially in reinforced concrete construction where the extra cost for heavy loads is very slight.

This very point brings up another argument in favor of general design. In almost any light manufacturing the processes are changing from time to time. Sometimes very heavy machinery is introduced. In the next case, light machinery may replace the heavier machines. In other words, even in running a given business there is change in methods. And thus in designing a plant it is well to keep in mind the possibilities of changing the uses of the building from those for which they were first designed.

No point was brought more forcibly to our attention in visiting factories than the advisability of providing amply for expansion. We took this question carefully into consideration in designing our plant. In many of the factories we visited, the symmetry of the design of the plant was spoiled because this factor had not been carefully considered. From our observation there is no more common mistake than failing to allow for ex-

pansion. The concerns which we visited before we designed our own plant were as a rule all successful ones, and because they had the elements of success they had in nearly all cases grown beyond their own expectations.

The question of expansion was, of course, considered also in connection with the grouping of the buildings. This of itself is a very important part of factory design. Unless the buildings are grouped logically with reference to each other and to the administrative departments, considerable lost motion is bound to occur. This means waste, for if work has to retrace its route of travel in process of construction, more truckmen and more floor space are required to handle it expeditiously than is the case when the route from raw materials to inspection and shipment follows a straight line without re-entrant angles.

DESIGN *of the building and details of factory construction which make expansion, sale or change in methods of manufacture possible and easy.*

Types of buildings possible in selecting an arrangement to meet given conditions are represented by the shapes of the capital letters L, T, U, C, H, F and E. In all these types of buildings, materials and parts in process of construction may travel in two or more directions without re-entrant lines on their way toward final assembling. Moreover, different lines of goods can be made in the various wings without interference and brought to a common point for storage and shipment.

In our case, the making of buttons, or in any light manufacturing business, the choice of a building had to do more with good light and efficient administration than with the processing. Parts are small and are

handled in large quantities and the shape of the building is not so important in its relation to the handling of the material.

For any business the ideal condition would be a square with all departments nearly equi-distant from the central point of administration. Several of the styles of buildings typified by the letters permit this centralization of the administration forces. Furthermore, in our judgment, all buildings for light manufacturing should run east and west so as to give one long side to north light. An administration building can run north and south, but manufacturing buildings should always run east and west.

It may be interesting at this point to state that we laid out our plant on paper before we thought of looking for a site. We had this draftsman's ideal in mind before we purchased land for our present location. While it is necessary sometimes to build a plant to meet the conditions of the location, in our case we bought the ground to fit the design.

In connection with the floor plan of a building, its length, breadth and height, several things are to be noted. A building three bays wide (two rows of columns) has, usually, a more convenient interior than one with two bays or four bays with a row of columns down the center. Again, sixteen to twenty feet is the most economical column spacing and therefore, under our conditions, a building fifty-two feet wide (three bays of about seventeen feet each) seemed the most satisfactory. So much of our work must be done near the windows that a wider building would have been wasteful of floor space.

For any given width of building the minimum cost per square foot of floor space is usually obtained in a

structure four or five stories high. The minimum cost decreases rapidly as the building lengthens up to 300 feet. Our buildings were, therefore, constructed four stories high and approximately 300 feet long.

We decided upon four stories as the height of the structures also for another reason. With four stories no passenger elevator service is necessary. By locating our offices on the second floor and the storeroom and repair departments on the third floor, employees have little occasion to climb more than one or two flights of stairs during business hours.

In a building fifty feet wide it is possible to get a satisfactory diffusion of light with a ceiling height of from thirteen to fourteen feet. A slight increase in height, however, adds very little to the cost per square foot. And the added height has certain advantages. By making our ceilings fifteen feet high, we have a better light and can place in any story a mezzanine floor which will have ample head room both above and below it.

Our building was designed for sufficient floor load to permit such a mezzanine at any and all points and a grip and nut head were set in concrete for suspension for such a mezzanine at all points. There are several places in our factory where such a floor can be used. Among other advantages, it provides for expansion without rearranging the machinery on that floor. It can also be advantageously used for storage.

Another general feature of construction which works out well in our plant is the elimination of a basement in the buildings. All the first floors in our factory are about one foot above the ground level. This cost was little if any more per square foot than for a building in which the basement floor was three or four feet below the ground level. Our ground level building, moreover,

saves lowering and raising raw stock and product.

Steel, concrete and glass are the principal materials of construction. Reinforced concrete is used for side walls and floors. The partition walls in several instances are of terra-cotta tile. A large percentage of the wall surface of the building is glass. Since the main building runs east and west, the natural lighting would be hard to improve.

While no attempt at special ornamentation was attempted in the buildings, the proportioning of the buildings and the simple cornices present a pleasing appearance. The surface of the concrete is bush-hammered except for a smooth border line at the corners and window frames. The treatment breaks up the monotony of a flat concrete surface and serves, with the windows, to make the buildings not out of harmony with the residential district in which they are located. The effect is further enhanced by an attractive setting of trees and shrubs.

EVERY *factory manager must look at his plant from the standpoint of use—not space. He must consider how much time it will take to turn his product out in that amount of space, he should plan to make the most use of his building and equipment. Then and then only will he get the greatest returns from his required investment and the lowest cost per unit output.*

—P. L. Battey

Chief Engineer, Industrial Department, The Arnold Company

IX

MAPPING FACTORY DEPARTMENTS

By Nicholas T. Ficker
Efficiency Engineer

IN DRAWING up a chart for a manufacturing organization, give careful consideration to the method of grouping the various units. Study the scope of the various departments and group them to get the best results.

First you must decide on a standard method of designating the various units. The factory, for example, may first be divided into its various branches. The branches are then subdivided into divisions, the divisions into departments, the departments into sections, and the sections into groups or gangs, each having its own particular organization. In the manufacturing departments, the subdivisions of a section are called gangs; in the clerical departments, groups. These various subdivisions may then be assembled in a chart which will show their various relations.

In the metal industries, a standard method of procedure is to divide the plant into five branches: mechanical, manufacturing, inspection, service and maintenance, and production and clerical branches, respectively.

The mechanical branch is comprised of the purely mechanical departments, such as tool design, tool making, pattern making, and so on, and is under the supervision of the master mechanic.

This manufacturing branch includes all those departments which are actually engaged in producing the output. It is subdivided into the foundry, machine, assembly, finishing and special divisions, respectively. Each division is put in charge of a division head to whom the foremen of the various departments report.

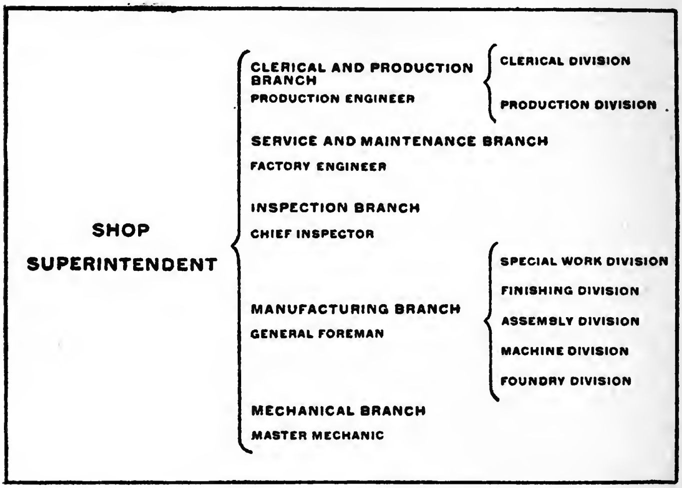


FIGURE VI: This chart indicates the lines along which to chart a complex organization. In actual practice it is best to carry the analysis out in much greater detail

The general foreman is in charge of this branch of the company, and is held responsible for the output of his various departments. The inspection branch consists of the raw material, process, final and tool inspection departments, respectively, and the chemical and physical laboratories, all of which are engaged in passing upon and maintaining the standards set for the guidance of the manufacturing branch. The chief inspector is in charge of the inspection branch and has direct

supervision over all the departments.

The service and maintenance branch is under the supervision of the factory engineer, and is comprised of the factory service department, house carpenter department, millwright department, steam and electric generating plant, and house wiring department; all of these are engaged in providing suitable accommodation for the enactment of work throughout the plant.

The production and clerical branch of the company may be comprised of two distinct divisions: first, the production division which takes in the shop stores, stock records, shop tracing and receiving departments, all of which are engaged in exercising their respective functions in connection with the subject of material; and second, the clerical and accounting division, which includes such departments as the shop cost, shop expense, payroll, employment, piece-work rates, voucher, shop purchasing and efficiency departments, practically all of which are engaged in keeping and furnishing statistics for controlling the various units throughout the plant, installing methods conducive to accurate costs, compiling piece-work rates, and controlling waste wherever possible. This branch, with its two divisions, is often best placed in charge of a production engineer, who should embody all the qualities of a mechanical engineer, office manager and expert accountant.

STUDY *of the departments in any factory will show which are closely related to one another—for effective work these should be placed close together.*

Take a machine shop, for example, as work on orders in most large manufactories of this class starts in the foundry. The grouping of the various parts of a brass foundry is typical. A study of conditions will show

that there are four distinct parts to the foundry division—the core-room section, melting section, molding section, and cleaning, filing and sorting section.

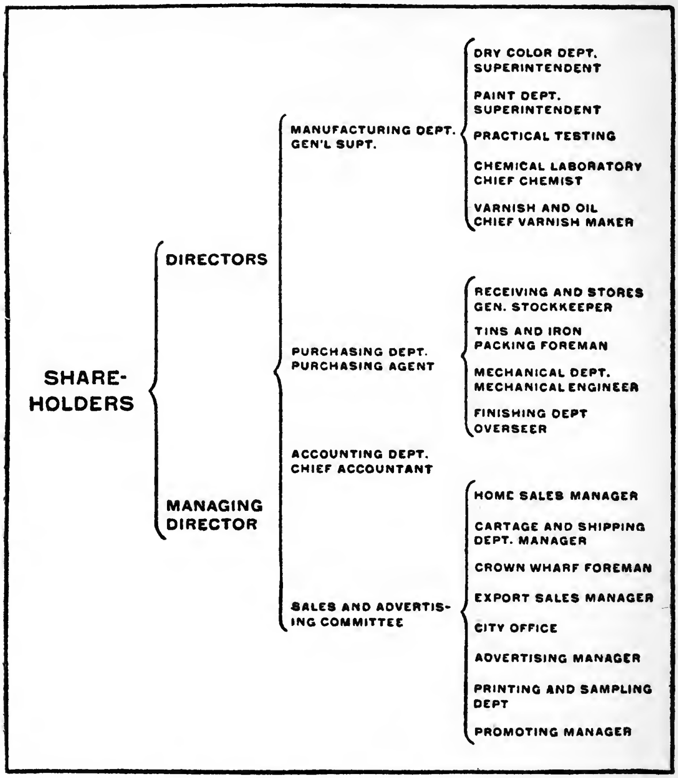


FIGURE VII: A British paint and varnish factory uses this method of mapping its organization. The dual authority of a board of directors and a managing director is unusual

Each of these sections is generally in charge of a section boss, to whom report the gang bosses, as happens in the case of the melting section, where are found the

melting gang and also the pouring gang.

This further subdivision is, of course, necessary only where the size of the foundry warrants it. As the

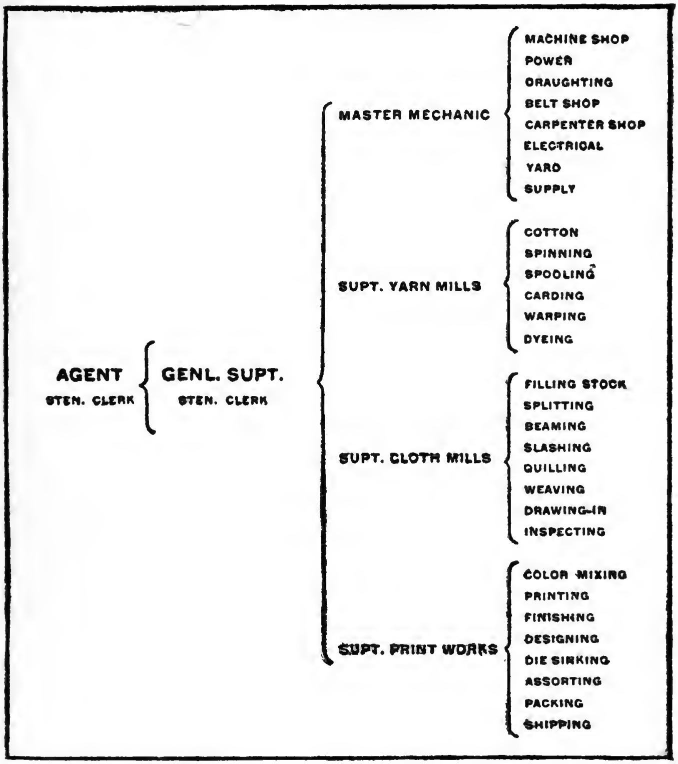


FIGURE VIII: A textile mill is essentially a group of independent little factories within a larger one, as this chart shows. It indicates the authority of department heads and their relation to the agent

charts show, the subdivision of departments depends on the class of business. In the paint factory conditions are different from what they are in a machine shop. Yet the methods of subdividing are not dissimilar. It

will be seen that each unit of the organization is so subdivided, and the duties and scopes of each part are so plainly mapped out, that friction between the various units is practically eliminated owing to a clearly defined distinction between their work.

The machine division is usually the main part of the shop and comprises all departments which cannot be considered as either assembly, finishing departments or special departments. Among the standard departments under the machine division will usually be found the milling, drilling, tapping, screw machine, punch press and lathe departments, respectively, and such other machine departments as are peculiar to the manufactory in question.

In the machine departments, the method of subdividing each unit is carried on in much the same manner as in the brass foundry; each department is first divided into sections and then into gangs. The direct benefit of such a plan of departmental organization becomes evident where gang piece-work is in force, and statistics relative to the efficiency of each gang are required. Too much emphasis cannot be laid on the fact that to whatever extent a departmental organization may be carried, it is essential to define the functions of each unit and specify the authority of the individual in charge.

When it is necessary to keep departments of a special nature separate from any of the divisions specified, they should be shown as such on the organization chart, and their department organization just as carefully worked out as though they were of a more standard nature.

Of even more interest than the inter-relation of the various departments under the manufacturing branch, is the grouping of those departments engaged in in-

specting and passing upon the product. The inspection branch should be in charge of a chief inspector, who will report direct to the shop superintendent as to his findings.

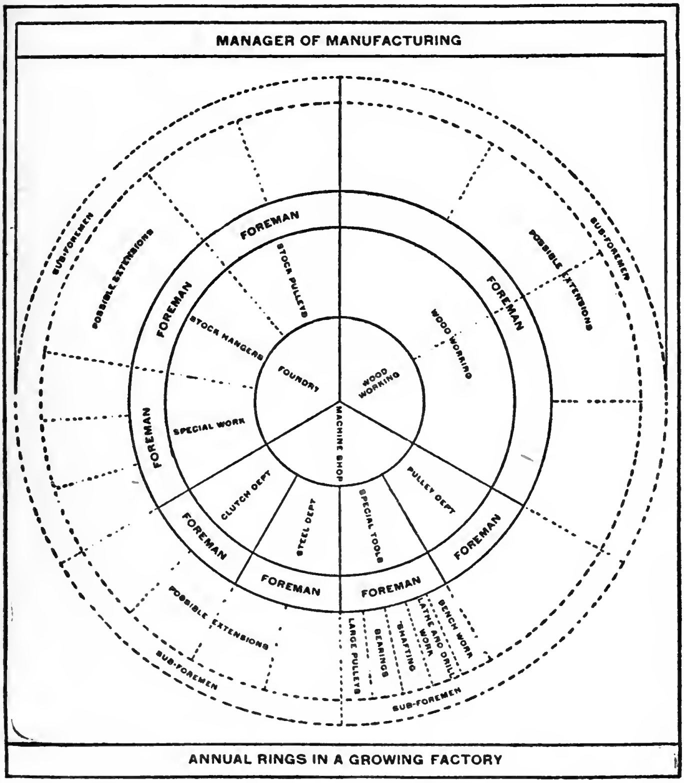


FIGURE IX: This chart is used not only to represent actual departments in the factory, but also to show their logical growth, making new charts at a later time unnecessary

In making a distinct branch of the inspection departments, instead of including them with the manufacturing branch, the policy of eliminating as much as pos-

sible the checking and inspecting of a department's work by itself has been followed. Past experience has shown that where the inspection work is part of a department's routine the results are generally unsatisfactory. This is usually due to a tendency to cover up defective workmanship and errors, or a gradually increasing laxity in inspection, until it is such in name only.

The policy of grouping all inspection departments under one head and taking these departments from under the jurisdiction of the manufacturing branch seems, therefore, to be warranted. As to whether or not the inspection branch should still come in the province of the general foreman, as head of the manufacturing branch, has been a subject of much contention; the consensus of opinion, however, usually favors the keeping of all inspection work directly under the supervision of the shop superintendent acting through the chief inspector.

The inspection branch in a large plant may be subdivided into: raw material inspection, process or worked material inspection, final inspection, laboratory, and tool inspection, each named in accordance with the degree of progress of the work, except in the case of laboratory and tool inspection. As each of these various divisions may be composed of a number of departments located throughout the floors and buildings of the plant, it is often worth while to name them in alphabetical terms.

The heads of the various inspection departments should bear the same relation to their respective departments as the foremen bear to their departments, and all shop instructions which are issued to foremen should also be issued to the heads of the various inspection departments.

The inspection department has no direct supervision over workmen, but should an inspector discover work which is being done incorrectly, it is his duty to notify

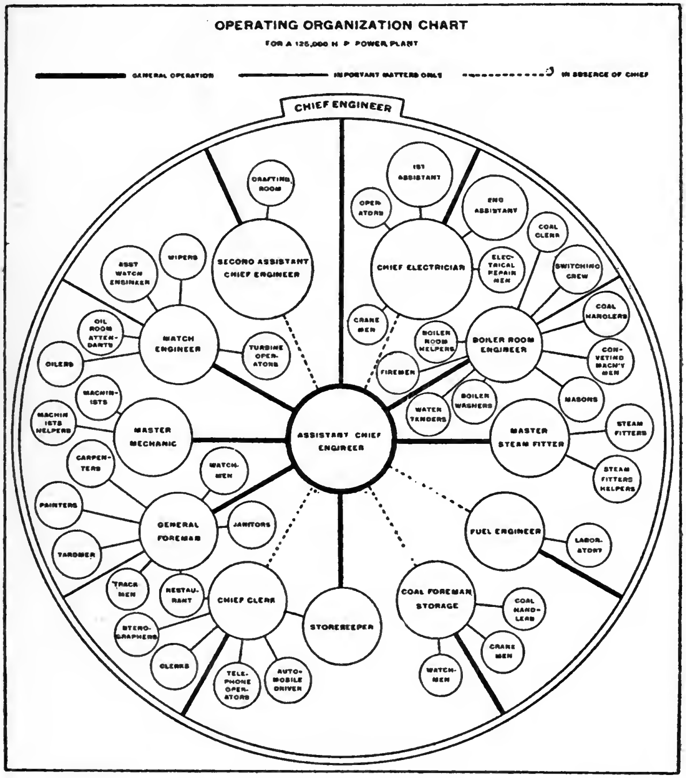


FIGURE X: This power-house chart is unique because of the clever way in which subordinate authority is represented. It gives every man a definite idea of his exact place in the organization.

the foreman in charge of the work immediately. In such an event, the foreman notified must stop the work until the error has been corrected. In cases where a

foreman neglects to take the necessary steps to prevent loss to the company after being notified by the inspector, or if the matter be of a serious nature, the case should be reported to the head of the inspection branch.

PARTS *of the factory which naturally belong together—how to chart the organization so as to show the exact relation of each department to every other.*

Whenever it is necessary for any reason to deviate in any way from the specifications or blueprints in the manufacture of any piece of shop merchandise, always obtain the approval of the chief inspector before proceeding with the work. Shop foremen must cooperate with the inspectors to see that this rule, when made, is strictly adhered to, as it is essential that blueprints be followed in detail. If it is known that errors on them exist, have the matter reported at once to the chief inspector, so that the particular case in question may be investigated before the blueprints are corrected by the drafting department.

The service and maintenance branch of the factory is another department in which there is a common interest. This branch consists of all those departments engaged in providing and maintaining efficient manufacturing conditions. It may, for example, include the watchmen, cleaners, elevator operators, known as the service department, the house carpenter's department, the millwright department, which includes the machine oilers, pipe fitters, millwrights and motor tenders, whose primary duties are to keep the transmission equipment at the highest state of efficiency, and also to make such changes in the plumbing and steam systems as may be required from time to time.

Under this branch comes also the steam and electric

generating plant, which is responsible for the operation and efficiency of all equipment and auxiliary apparatus in the boiler and engine rooms. In some big factories there may also be the house wiring department, whose

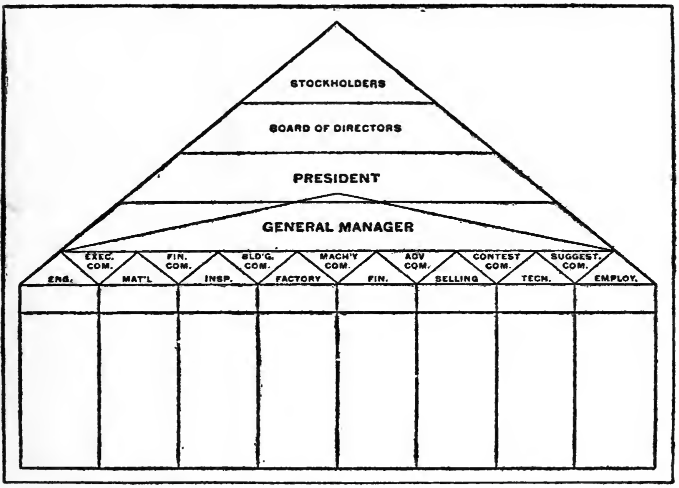


FIGURE XI: The pyramid chart shown here is used in many organizations. Each department—sales, manufacturing, and so on—has its own pyramid which fits into the pyramid of general organization.

primary duties are the making of such repairs and changes to the electric wiring, both for illumination and power, as may be required.

These departments, like the strictly manufacturing departments, may each be under the supervision of a foreman and have a regular departmental organization similar to the productive departments. The branch as a whole is in charge of the factory engineer. He may report to the shop superintendent relative to fuel and power consumption, and also make such recommendations for increased equipment as, in his judgment, are

required for the most effective operation.

How the production and clerical branch of a machine shop may be organized in two distinct divisions, the production and clerical divisions, respectively, is shown in Figure VI.

The work of the production division consists of scheduling orders through the work, determining maximum and minimum stock limits, supervising the work of the store rooms, and placing orders on the purchasing department for raw material. The clerical division keeps accurate records relative to the operations of the various departments throughout the factory, the expense and output of each, the degree of efficiency as shown by comparative statements, and so on.

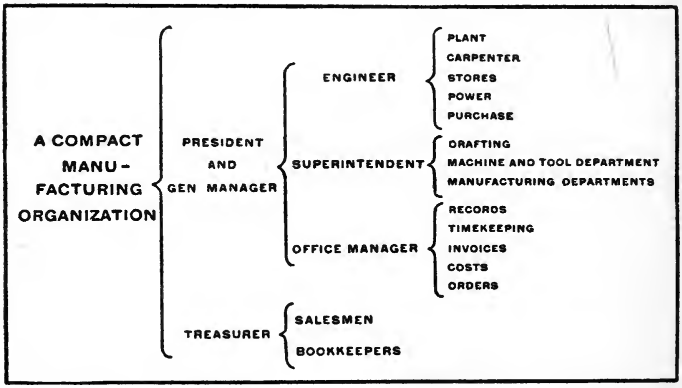


FIGURE XII: Analysis of authorities in a small plant, in which individual abilities largely determine duties, is here shown. Similar analysis can be made in every plant and should be graphically represented

These general tendencies in charting the organization of a metal-working factory hold good in many other classes of manufacturing. How conditions in different classes of factories affect the application of principles is

made clear in the charts. Naturally, in the small plant, the subdivision of branches is not carried to the extent deemed advisable in larger plants. Yet the form of the chart in such an industry may be such that the chart expands naturally with the business.

The charts may vary in form. The "balloon" diagram (Figure VIII) is perhaps most widely used. But the "pyramid" method (Figure XI) has been adopted by some large organizations. The chart may be shaped to indicate control in other ways. Take the unique power house organization diagram illustrated in Figure X. Here the outer ring represents the authority of the chief engineer, while the lines to the central ring show the authority of his assistant when the chief is present and when he is absent. Other methods of representation are illustrated in Figures VII, IX and XII.

OBSOLETE *machinery is the foe of profits, the brother of high cost and the friend of bad methods.*

—William C. Redfield
Secretary of Commerce

X

HOW TO LAY OUT MACHINERY

By D. C. Eggleston, M. E., C. P. A.

CORRECT location of machinery in any factory requires the consideration of many items, for the most economical arrangement of machines is reached only after plans have been made which include the relation of aisles, power, light, handling of materials to and from the machines, foundations and blowers.

A great deal of space is sometimes wasted unnecessarily in aisles, and because machines are poorly arranged with reference to shafting, power is often wasted in transmission. This arrangement of machines with relation to power is often complicated by the fact that light has to be considered. In one factory the workmen had to stand with their backs to the windows and were consequently always in their own light because the line-shafting had been laid out so that the power could be transmitted to the machines only when they were facing toward the center of the shop instead of toward the wall.

Proper consideration must be given to the handling of material to and from the machines. A great deal of space can be saved by handling material to and from the machines on trucks and, of course, the character of the material must always be taken into consideration, for, as in the case of automatic turret lathes, material is

fed to the machine in rods and bars of considerable length, and space has to be provided for getting this material to the machines.

The location of cranes, hoists and blowers all have their effect on the arrangement. In building several stories of mill construction the question of foundation has to be carefully considered. In concrete buildings the floor loads can be distributed with considerably more freedom over the floor space than in buildings where wooden floors are used. In laying out machinery, consequently, either in a new factory or in re-arranging departments in an old plant, best results are obtained by making a plan of the work so that the exact location of all the equipment and its inter-relation can be seen before changes are made.

BLUEPRINTS *of the floor plans showing where each machine is located are a valuable aid in preparing for the most economical handling of the work.*

Floor plans of this sort have another advantage. In one factory the prime object of laying out a plan of this sort was to shorten the time in taking an inventory. In this factory were a great many tools more or less similar in character and every year at inventory time a good many hours were wasted in identifying these tools and checking them with past inventories. After floor plans of the factory had been drawn and each tool located with its names, all tools were given numbers. These numbers were painted in red on each machine so that thereafter the plan of the factory was in itself an inventory of the operating equipment.

One of the quickest and most satisfactory ways of laying out machines is to cut templates out of cardboard the shape of the space obstructed by each machine

or fixture. These templates are made to the same scale as the architectural drawings of the floor plans so that when they are arranged on the drawing they show at once the relative location of all the machines in the building. This plan can be followed in both the large and small factory to advantage. In one large factory where department changes are constantly being made, standard sets of templates are made for different machines and are filed in the drafting room so that no time is lost in laying out a new department or rearranging an old one.

First a blueprint is taken of the plan, then the cardboard templates corresponding in size to the floor space used by the machines are placed upon the blueprint with due reference to the proper methods of arrangement noted above. By using templates in this way it is a simple matter to arrange machines so that the work can be routed through a department from one machine to another. The whole story is told on the drafting board, and by fastening the templates to the board temporarily by pins or thumb tacks the layout of the department can be studied exactly as it will appear. In developing a plan of this sort a good many unusual conditions will be found not otherwise considered.

Sometimes local boards of health require that a certain number of cubic feet of air be assigned to every operator in order to prevent overcrowding in the factory. This must be taken into account when making the layout. Sometimes store rooms not only for raw material but also for material in process help reduce the amount of aisle space required. Generally one-half of the private aisle is allowed for operators on the machines and one-half for the transportation of material. Screw machines may be staggered so that the

rods will not interfere with each other or they may be set at an angle so that the rods of material entering one machine will lie behind the next machine.

After the plan has been thoroughly considered and finally laid out, a drawing of the arrangement can be made for reference. These final drawings are of value in answering questions which would otherwise require considerable time. It may be necessary, on account of production, to add a new machine or substitute a larger type machine for one already in use in a department. Instead of having to go out into the shop and measure up the location with reference to the floor plan on which the machines are laid, any scale will quickly show whether the new equipment can be arranged for.

When any changes are made in the arrangement of machines the corresponding changes should, of course, be made in the drawings. In one factory, one set of blueprints is kept always in the safe so that it may have a value in proving the amount of loss in case of fire. Blueprints of this sort may be supplemented by card indexes of machine equipment showing the purchaser's name, date of purchase and in fact a complete history of each tool in the factory. In the small factory, however, much of this information can be kept conveniently on a chart, without an additional set of card records.

THE *way it was done* may *be the best way. But in any event, no matter what the business, it pays to get outside the detail occasionally and look* into *the factory, not* at *it.*

—F. C. Cutler

Of The Worcester Pressed Steel Company

XI

MAKING STRAIGHT PATHS FOR WORK

By S. F. Joor
Conveyor Engineer

STRAIGHT line work in a stove factory has come to high perfection through the use of a thoroughly up-to-date conveyor system, which does away with the constant picking up and putting down of work. In this concern, stove castings are received at one end of a long assembly conveyor which travels at a very slow rate of speed. As the castings move along the conveyors, they are removed at three or four drilling points, located a short distance from the receiving room, where the various parts are drilled. Then they are placed on the same conveyor, which carries them to the polishing and plating department. Here the parts are automatically removed, polished, plated and stored until finished, when they are again placed on the conveyor and passed to the assembly department.

The various assembly parts are stored by means of auxiliary conveyors in bins arranged to receive these parts, so that as the operator assembling finished stoves passes these bins adjacent to the conveyor, he takes from them the parts required. The partially assembled stove is just in front of the bin where the next parts to be used are stored. Each part as it is successively wanted is taken from the bin and connected to the practically assembled stove so that by the time the slow

moving conveyor has run clear through the length of the assembly room and passed all the storage bins, the various parts necessary for the complete stove have all been assembled on a moving assembly table or conveyor.

ECONOMICAL *processing of work requires that it pass in a straight line from receiving room door to shipping room door—how conveyors help.*

As it passes the wrapping and crating department, the necessary operations there are performed, and the stove is then moved on by the conveyor to the loading department and from there to the cars. In the assembly of these stoves all but the absolutely essential manual handling of material has been eliminated. There is no unnecessary picking up and putting down of material, with its consequent waste of energy, time and money.

In ideal factory transportation the material should move from the crude state to the complete finished product without manual handling at any stage and should pass through the shortest possible routes. This main idea that crude material should be received at one end or side of a plant and, with the necessary provisions for local and temporary storage, pass from a conveyor system carrying the crude material to the machines which will treat it successively, should be adhered to as much as possible.

There should be an arrangement to feed the material right at the machines, stopping it automatically until it is removed and treated by the machine, then replacing it on the conveyor immediately at the machine for transmission to the next stage of treatment. At the stages where partially completed material must be stored

temporarily, provision should be made to store it as near as possible to the point at which the treating process takes place. The storage space should be accessible by power or by gravity in both directions and, if by gravity, the movement should be under full control at all times.

Many factories have little more idea of the proper method of providing straight lines for work than is exhibited in a preserve factory. In this concern, the bottles are received in crates and carried to the top floor. All empty boxes are delivered on the same floor. The bottles are opened and washed, the boxes lined with paper, and then the clean bottles are turned mouth down in the boxes. Next, the boxes and bottles are piled together on a truck, taken to a platform elevator and lowered to a room on the next floor. One elevator serves a floor space approximately 150 by 200 feet.

The preserve material is prepared and cooked in several different parts of this room, with the exception of the flavoring extract department, which is separate. Yet both departments are served with bottles by the same truck. The truck is stopped in front of the cooking department and the material taken off. The bottles are taken out and filled with the cooked product, put back into the boxes again, packed and piled onto the trucks. They are then taken to another portion of the room to be inspected. Here they are unpacked and repacked, loaded on another truck and carried to the labeling and corking department located in another distant part of the room.

They are then unpacked again, the labeling and corking inspected, repacked, the material loaded on a truck and taken to the shipping room where the covers of the boxes are nailed on. Some of the material going into

bottles must remain uncorked for from twenty-four to thirty-six hours. Bottles containing this material are sent up into a temporary storage room where they undergo additional handling.

There is a continual picking up and putting down of material, constant wastes of energy and time. This occurs in every factory to a more or less extent, the amount depending in a great measure upon the consideration given the subject of transporting materials in the most economical and efficient manner.

If this factory had been designed with a view to efficient routing and transporting of the factory products, the bottles would have been placed in some form of conveyor and passed directly to the cleaning department, from there to the filling department, where they would be filled without leaving the conveyor, and then passed on to the inspection, corking and labeling departments. The material to remain uncorked for a certain period would pass on to a storage conveyor and, after remaining for the required length of time, would be returned by the same conveyor and passed on to the inspection and packing departments with only one handling. The loss of time and the consequent increase in cost of production is wholly due to the failure to plan production so that it will follow straight paths from receiving room to shipping department.

In every factory conditions of routing and transporting factory products can be improved to a great extent by a careful study of a proper conveyor system to eliminate the constant picking up and putting down of work. Any system installed in a department or unit must not only be considered on the basis of immediate saving, but upon the relation of this system to the factory as a whole.

Conveyors serve to eliminate the labor of handling operations which would be unnecessary if the factory were laid out at the very beginning with the proper conveyor equipment.

In the ideal system each successive stage should be carried out along the direct line of development of the product, so that the process material entering the conveyor system at the crude material end will pass successively before each stage of treatment without being packed into any kind of receivers, and without any care as to handling by the men who actually conduct the process upon the crude material. It should be handled as far as possible without trucks and without mixing up material in storage. The process material should go from the crude to the finished stage by a fixed and definite route, and should move at a definite speed and in definite quantities.

DIFFERENT *kinds of material require the use of different types of conveyors—elimination of the constant picking up and putting down of work.*

When the treatment is more or less complex and the partially treated material must pass through several different routes to be worked up into various forms of finished product, it is necessary at certain treating points to have elective routes where the material may pass to these divergent points. But the main idea that the material must pass through the entire treatment without manual handling, by the shortest possible route, and should move in the most economical quantities and at the least expensive speed, should be strictly adhered to.

Many factories conform, more or less, to these principles. For the handling of finished product in the

storage room, a most flexible form of conveyor for packages of reasonable weight is an electric hoist, self-propelling, on a steel overhead tracking system which allows the deposit of finished material in boxes without manual handling, and also allows the removal of these boxes by the same electric hoist system from the store rooms through hatches over the shipping floor below.

Various classes of material, of course, require different types of conveyor apparatus. If the material is gritty and in bulk, the belt conveyor form is practically the only satisfactory means of handling. In the case of optional routes, short portable conveyors may be used. Several of these may be coupled up in groups in order to cover a longer distance. This portable system may be broken up in a very few minutes into a number of units to be used in different places.

If material is more or less in large pieces, the belt is readily replaced by a conveyor made of wooden slats running on rollers which forms a wood surface that can be operated under all conditions where the belt is used, except for the portable features which are not readily accomplished in this case. Many of these conveyors will operate at an inclination of twenty degrees and can be made light enough to handle money orders for post offices or strong enough to carry heavy castings and forgings. For handling sand, broken stone, coal and similar material, a standard pivoted conveyor is probably the most economical.

Picking up and putting down material consumes in the course of a year a very large amount of time and labor. And in every factory these wastes exist in a greater or less degree. They are preventable and should be eliminated. The one thing constantly to remember is to plan work so that in routing it the raw materials will

proceed in a straight line from first to last, as far as this is possible. Zigzag traveling of work in process from one part of the shop to another is often a big item in shop wastes. Conveyors and automatic devices do away with the necessity of constantly picking up and putting down work, and by properly selecting them, time and money can be saved in operating the factory. Not least valuable is the point that automatic conveyors set the pace for work in the departments where they are used.

ORDERLY *production is the basis of economical production. When a factory can be arranged so that buildings form consecutive links in the production chain, starting with the pattern shop and ending with the complete machine on the erecting floor, that plant has a basis of operation which approaches the ideal. And what is true for the buildings collectively holds good for the individual shops. Tools must be so arranged that the work starting at one end of the building moves naturally down its length without kinks which cause confusion and lost motion in the line of production.*

—O. W. Mueller

President, The Mueller Machine Tool Company

XII

MAXIMUM OUTPUT FROM YOUR MACHINES

By Henry M. Wood
Of The Lodge & Shipley Machine Tool Company

ELIMINATION of idle machines is the final aim of nearly all revised shop methods. The factory manager often finds that a modern machine tool will give four times the output of one of his old ones. The greater the productive capacity of a given machine, the greater is the loss in output whenever it is idle. In addition to this loss, it is more than likely that the new tool represents a greater first cost, so that somewhat heavier interest and depreciation charges have to be met before the machine will show a profit.

To utilize to the fullest extent the possibility of increased production and avoid loss due to heavy interest charges on investment, means that changes must be made all along the line in the old order of shop practice.

First, methods may have to be adopted to meet the newer equipment by a general keying-up of production. Next, you may have to consider how you handle material between machines. Finally, the relation of the man to the machine, the cost of tools, supplies and power in turn must be considered if each machine is to be used to the best advantage.

Every factory man knows how a new machine may demand a readjustment of methods. Not as many realize that there may be a shop policy. In our plant,

for example, a number of boys do nothing but run errands for the machinists to and from the tool room. Thus a twenty-dollar man is not doing work which a five-dollar boy can do just as well. And what is of even more importance, the operator remains at his machine so that the output is not temporarily stopped.

THOROUGH *analysis of operations and conditions eliminates unnecessary movements which lessen workmen's efficiency and cut down output.*

Formerly, each machinist filled out his own time ticket. Now it is found more economical to have special timekeepers who periodically make the round of all machines and jot down all of the data which heretofore each operator had recorded for himself.

This new method of marking the time tickets is used partly for the convenience of the cost department, and partly to prevent an idle machine while the operator might do his own bookkeeping.

Another of the main questions involved is the policy of handling materials. Machinists are not allowed to run out of work. A recent shop rule requires that each operator be supplied with work for one day in advance. To insure the carrying out of this rule, and to prevent the sidetracking of needed material, a complete system of routing has been worked out, covering all of the shop departments through which each piece must pass from the receipt of the raw material to the assembling of the finished machine.

To check up the work and see that the various pieces are promptly moved in accordance with their routings, a special trace clerk is continually making the rounds of the factory.

Adequate crane service in a plant handling a medium

or heavy line of work becomes more and more essential with the introduction of more powerful machine tools. For moving the lighter parts hand trucks are used. They require definitely marked-out aisles and a strict rule that no material ever be stored even temporarily within the "dead line" marking the boundary of the aisles.

The movements which the operator has to go through in handling work in and out of his machine will bear careful analysis. This is one of the important aspects of scientific management. Never compel a man to be continually stooping in order to pick up small parts from the floor. Such work should be placed by the laborer who does the trucking on racks within reach of the operator and arranged in regular order.

Often a "shop kink" to suit the individual case will enable the operator himself to reduce considerably the time lost in handling the work in and out of his machine. In milling the bases of sad irons a rotary table is used with independent checks for holding six irons; the table is revolved continuously by power so as to feed the irons successively past the face mill which does the surfacing; while the milling cutter is machining the irons on one side of the table, the operator at the other side removes the finished castings as fast as they come around and replaces them with rough ones; thus no time at all is lost during the chucking operations. A similar saving can be made in the lathe department, on work turned between centers, by using two dogs; while one piece with dog attached is in the lathe and under cut, the operator removes the second dog from the piece last finished and attaches it to an unfinished piece ready to put into the lathe as soon as his cut runs out.

The usual prejudice to be overcome in introducing a new machine is the workman's idea that such greatly increased output will mean throwing men out of work. It is the same old objection that was offered to the introduction of the steam engine. High-grade men have to be educated to a realization of the fact that more production means greater total wealth for the community with greater opportunities even if the field for some may thereby be changed to other lines.

The more a man produces, the more he is worth; and one successful way of proving this fact to men is the premium system of wage payment.

Most modern machine tools do not require all round machinists for their operation. There is a tendency in design toward "single purpose machines." It makes for greater accuracy of work, increased production and general economy to have the machine operator specialize in one line of work so that he can become more expert.

For such cases almost any man of fair intelligence who is willing to be taught and to work will make good. Much responsibility must rest upon the foreman in carefully instructing men under him. Scientific management takes account of this fact, and the planning of the work is distinctly separated from the performance of the job.

In many cases the cost of tools will be the determining factor in deciding upon the type of machine. For example, on certain work the turret lathe with full equipment of high-priced tools is much faster than the engine lathe and, therefore, the best machine regardless of tool expense. On other work, the engine lathe will be much faster than the turret lathe.

In still another case, neither machine will show an appreciable gain in production over the other, but the

turret lathe will require an equipment of turners, hollow mills, dies, and so on, not only high in first cost, but very expensive to maintain; the engine lathe requires two or three simple and inexpensive forged tools. In this last case the lower tool cost would make the decision unquestionably in favor of the engine lathe.

Similarly, it will sometimes happen that a planer will be a better investment than a milling machine, because of the lower cost of planer tools.

As to choice between modern high-speed steel for cutting tools and the old carbon tool steel, the former is almost always the better investment. High-speed steel may cost several times as much per pound, but it is so much more durable and can be worked at cutting speeds so much greater that the difference in first cost is negligible.

Power required to drive a machine increases as the output increases, but not quite in direct proportion. Suppose an old lathe, consuming three horsepower, is replaced by a new lathe, requiring ten horsepower but capable of turning out four times as much work. At a liberal allowance the new lathe would cost fifteen cents per hour more for power than the old one.

Against this increased expense, consider that the output is quadrupled, where the operator's pay combined with the overhead charges for manufacturing expense and selling expense would be at least eighty-five cents per hour. The increased output would mean a gain of \$2.55 per hour, less the increased cost of power, making \$2.40 net gain.

The increased power required by a rapid production machine tool, therefore, is not a factor to be considered.

Wage systems, of course, enter into the problem of securing maximum machine output. You must first

offer the worker increased compensation for the increased effort necessary to secure the greater output and, second, you must have the cooperation and confidence of the men. With such a payment plan in operation, and with the prompt and continuous performance of orders assured, work progresses with fewer hitches than ever before. Both foremen and workmen are striving to their utmost to get their premiums. The little chats that were once indulged in by the men are entirely done away with. Each vies with the other for supremacy in his work, and unproductive hours are reduced to a minimum. Idle machines rapidly disappear.

IN ORDER *to increase production a manager does not study his plant in a lump sum, but goes through his shop and analyzes each operation and movement. It often happens that he discovers astonishing possibilities that have hidden themselves for years in the most transparent disguises.*

—F. C. Cutler
Of The Worcester Pressed Steel Company

XIII

FIGURING DEPRECIATION ON EQUIPMENT

By Herbert Foster
Lecturer in Yale University on Problems of Business Management

ONLY within comparatively recent times has the manufacturer in the United States come to realize the necessity for system and uniformity in inventory and depreciation. Formerly the one item carried on the books, supposedly representing the value of the asset—machinery, tools, and so on—was deemed sufficient for all practical purposes and requirements. As time went on, however, it began to be recognized that some more specific and detailed record was essential.

Take the case of machinery, for instance. Granting that the amount carried on the books represented even the true value, it was for machinery as a whole; there were no records indicating the value of each separate unit entering into the aggregation.

In some few instances an inventory of all machinery would be taken at not very oft-recurring times, valued, and the aggregate compared with the total value carried on the books; but this was the exception and not the rule.

How a continuous inventory was introduced and maintained in one factory in an accurate manner, without involving a great expenditure of time and labor, will suggest principles which can be applied by every manufacturer. It is a listing of machinery and other

fixed assets for the purpose of securing a complete unit record of correct and uniform depreciation, and for insurance adjustments, should the latter be necessary.

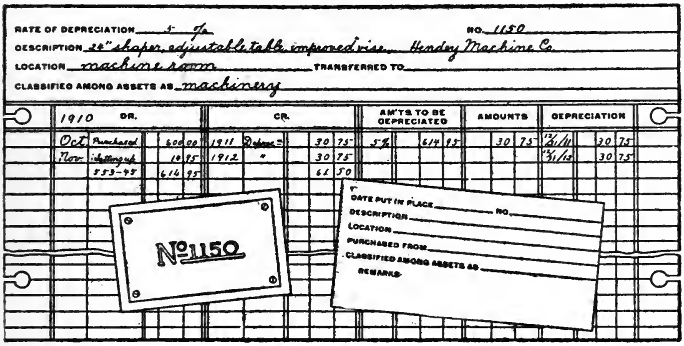
The asset machinery is taken up first. It is essential that each machine be numbered. Some factory managers accomplish this by painting the number on the machine in a prominent place. Experience proves that much better and more permanent results are obtained when a plate of brass or steel of suitable size, with the number stamped thereon, is affixed, preferably on the front of the machine. A brass plate bearing the number 1150 is shown in Form I. A card, properly spaced, is provided for recording the date the machine was installed, the number the machine is to bear, its description, where it is to be located, from whom it was purchased, and so on.

METHODS *and forms used to keep track of the running value of each machine, thus insuring that the exact cost and output of every one will be known.*

When a new machine arrives, a card (Form III) is filled out, and the number which has been assigned is marked in red ink on the original invoice for the machine for future reference.

This card, together with the plate bearing the number, is turned over to a person whose duty it is to see that the plate is duly affixed to the machine. Under the head of "Remarks" is written the exact location of the machine in the machine room, as well as any other necessary detail. The delivery of the card to the properly designated person in the office signifies that the number plate has been attached to the machine, and the record in the continuous inventory is made accordingly.

At the end of the month (if the voucher system is in use, it is done immediately) the invoices for purchases are analyzed to obtain the entries for the private journal; each item to be charged to the machinery account is taken separately, the red ink number is noted, and the corresponding card found for every item to be



FORM I (front figure at left): Number plate fastened to machines.
FORM II (front figure at right): Card on which machines are indexed.
FORM III (large sheet): Blank which keeps the complete history of each machine

charged. Any missing cards are located before making the entries, as it is essential that the charges to the account and the additional sheets correspond each month in order to keep the system in perfect agreement.

The information contained on the card (Form II) is then copied on a sheet ruled and printed as shown in Form III, after which it will be found advisable to file it away numerically for cross-reference purposes.

This sheet (Form III) is ruled and printed alike on both sides and has holes punched on both edges. When one side is filled, the sheet may be reversed, affording the user the advantage of being able to always write

on the right-hand side of the binder, which will be found most convenient in this or any other loose-leaf book.

In the debit column of the sheet is written the date the machine is purchased and the amount of invoice or the amount posted to the machinery account for this particular machine in the private ledger.

The sheet is then filed in its proper place in the binder, under the index page "Machine Room." This binder should be one of the ordinary ring binders commonly used, so as to permit of sheets being inserted or extracted at will.

The plan calls for a set of index sheets, one for every machine unit to be found in this room.

This sheet provides, in addition to the description, debit and credit columns, a column for "Amount to be Depreciated," a column for the amount of such depreciation, aand one also for the amount of depreciation written off year by year.

In the case of the sheet shown, No. 1150, in the debit column appears the charge, "setting up, $14.95." This charge, as the item indicates, is for work performed by the factory force in setting up the machine for operation and has been made to the machinery account on the regular books; the factory accounts, labor and supplies are duly credited.

The object of the "Amounts to be Depreciated" column is to designate separately such items as are to be depreciated. In Form III, according to the debit side of the account, the total cost of the machine plus the cost of setting up is $614.95. If an attachment should later be added to the machine, the value of this addition would also be placed in this column in a separate item, the amount of depreciation extended in the "Amounts" column and this amount added to that

already shown ($30.75). When depreciation is next written off, instead of the amount being $30.75, the new amount will be used.

These amounts of depreciation are placed to the credit of the account and the balance is extracted. This balance is $553.45, according to Form III.

After the sheets are checked the aggregate sum of all the balances should equal the amount of the machinery account on the private ledger after the depreciation has been deducted.

By listing on an adding machine these separate amounts of depreciation, as shown on each sheet, the total gives the amount of depreciation to be used for the account in the private ledger.

It will be seen that these sheets really constitute a subsidiary, detailed ledger, of which the machinery account in the private ledger is the controlling account.

Machinery alone has been made use of for descriptive purposes. It is apparent, however, that this same plan is available for all other assets. For instance, if tools are of such nature that those located in each room can be numbered and similarly kept track of, it would be well to do so, using the prefix "T" for differentiation; thus, "T706" would be understood to stand for "Tool 706."

Electrical equipment may also be separated and marked in a similar manner, using the prefix "E." "E915" would then be known to represent "Electrical 915."

By separating, numbering and recording all factory assets, and filing them under their properly designated "room-index-sheet," it is possible for one to have at his finger's end a complete, detailed inventory of the various permanent assets contained in every room on the

establishment, the history of each individual unit, from its original cost or valuation to its present value, the amount expended for new attachments, amount of depreciation written off year by year, and so on.

Even in the case of such assets as cannot be numbered —buildings, pipes and fittings, fire apparatus, shafting and pulleys, and so on—it is possible to figure out the correct proportion of the whole amount of such asset each room should bear, and to make out a sheet to cover it.

Should you have occasion to scrap a certain machine, as improved methods of production may well force you to do, the present value of your machine is at once ascertainable without any element of guess-work or uncertainty. You know precisely the relation of the initial cost to the scrapped iron.

FREQUENTLY, *it is found that some machines are standing idle more of the time than they are in use. When not in use they represent idle capital, floor space that is not only non-productive but floor space that is absorbing profits, because this unproductive space must be paid for in the expense of the establishment.*

—Leon S. Oliver

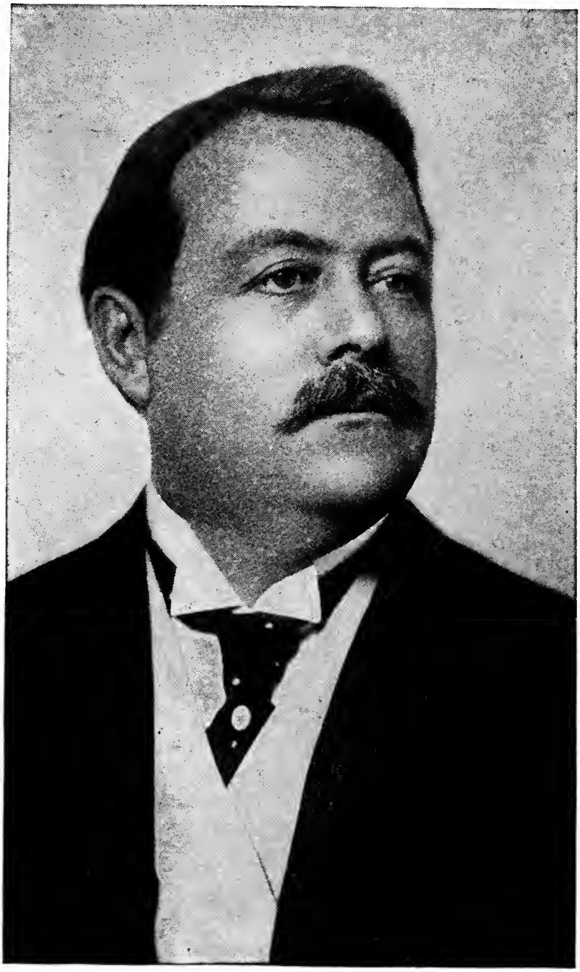
PART III—SELECTING A WAGE PAYMENT METHOD

Working with Your Men

I BELIEVE one of the greatest assets in the successful management of a large institution is the ability of the manager to surround himself with competent and loyal lieutenants, who will work in harmony and carry out the policy determined upon by the head.

It is a practice which has been followed in our experience of many years to first get the views and the opinions of these lieutenants, who are in close touch with the situation in their respective departments. This opinion is weighed carefully, and if, in the judgment of the management, the viewpoint is sound and logical, it is adopted and acted upon.

If, however, it is decided by the management to reject the recommendations of the assistant and adopt a different line of action, then the reasons for such action are given to the assistant, in order to insure his loyal and sympathetic cooperation.



FREDERICK ROBINSON

Vice-President, The J. I. Case Threshing Machine Company

XIV

PAYMENT PLANS AND WHERE THEY FIT

By C. B. Auel
Director of Standards, Westinghouse Electric and Manufacturing Company

OF THE three general systems of wage payment—day work, piece work and premium work—the last alone needs special explanation. In day work plans the employee is paid by the hour, day or shift, and the amount of work completed is not stipulated. In piece work, the next oldest, the amount of work done is paid for, regardless of the time taken.

Premium work, the most recent form of wage system, may be said to be a combination of day and of piece work. Both the time of employment and the amount of work completed are taken into consideration. The workman is paid a premium, generally in the form of an extra wage, for extra effort over and above that required for the average day's work. This extra effort is not always manual, for, with the opportunity of making extra compensation, the workman is led to develop many ingenious devices to aid him in securing the additional remuneration possible under such conditions.

No sweeping statement can be made as to which is the best wage system, because each has a field of its own. For example, in the making of dies, every piece may be so radically different from every other piece as practically to preclude any attempt in advance at gauging, within reasonably accurate limits, the time required.

to perform the work. Under these conditions the only rational method of paying for it would be by day work.

Day work offers no incentive to maximum output; a goodly percentage of workmen will, therefore, perform just sufficient work to satisfy their foremen and thus retain their jobs.

> WHEN *work is done by the day there is no incentive for maximum output—piece rates supply this incentive, but give the workman too large profits.*

On the other hand, in certain kinds of work, where the apparatus has become so thoroughly standardized as to permit of accurate estimates being made regarding the time required for the performance of each operation, and where the extent of competition is fairly well known, piece work may be applied to advantage. Payment for work which has become standardized in its main features, though the details continue to vary, is without doubt made most equitably by the premium system.

Day work is the most expensive method of payment as far as cost per piece is concerned. To offset this, however, it is often argued that the accounting features are less complicated with day work than in either piece work or premium work, which should tend to give a lower percentage of general or indirect expense; and, further, since no limit is fixed as a minimum output, the quality of the work is of the best. Increased output can only be obtained under this system by increased supervision.

In piece work and in premium work, the incentive exists for a maximum output; but the adherents of day work claim that the output may be obtained at the expense of quality.

There is a tendency, in any wage system with an

incentive towards increased production, for quantity to be reached through a falling off in quality. But knowing this, steps should be taken to safeguard quality by a properly enforced inspection. A skilled workman can usually make an article right as easily as he can make it wrong; but it is for the more unskilled among the number that the inspection is largely required. No premium should be paid on defective work; and, to emphasize this feature, the inspection should be so close to the actual operations that the workman and his work can be identified, so that if his product is not up to the recognized standard, he will have to make it so before its acceptance.

Judgment must be used as well in the selection of the system best suited to the work; for a wage system may be brought into disrepute, either by a wrong application, or by the way it is carried out, or by the spirit in which it is received by the workmen.

In piece work, the workman takes the entire direct profits—the amount earned by a piece worker—over and above what he would have earned had he been paid by the day or by the hour. The employer benefits indirectly through the increased output obtained in a given time from machines and floor space; also, by a lessening of the cost per piece for supervision, heat, light, and other overhead expenses.

The fact that all the direct profits go to the workman in piece work limits its application to the comparatively narrow field of what is practically repetition work; for the employer, assuming all of the risks and receiving only the indirect profits, cannot, in fairness to himself, be expected to apply this system to classes of work, the details in design and manufacture of which have not been thoroughly standardized and in which, accordingly,

considerable error may enter in the setting of piece work prices, making them entirely out of proportion to the value of the work.

Besides this, the indirect profits, particularly when considered in connection with individual jobs, sometimes exist only in theory or else are so intangible that advantage cannot be taken of them. It should also be borne in mind, too, that, regardless of what wage system may be used, the employer is compelled to share his profits with the customer in ever increasing proportions, through a gradual reduction in the price of apparatus, as time goes on.

COMPARISON *of different kinds of premium and bonus payment plans—Halsey, Rowan and Santa Fe —and where each system is most valuable.*

It was the seeming inability both of day and of piece work to meet fully average requirements that led to the development of more elastic systems, systems with a broader field of application, resulting in what are now known as premium systems; though there are already many such, it is not claimed by anyone that finality has yet been reached.

Under a premium system the employer, besides benefiting indirectly, generally shares in the direct profits with the workman, the proportion depending upon the particular system in force. Moreover, the workman is almost always guaranteed a day's wage based upon his hourly rate, while this is seldom the custom in piece work.

The most widely known of the premium systems is the Halsey system. In the original scheme, the time previously required to perform a job by day work was taken as the basis, and a premium offered the workman

equal to from one-fourth to one-third of his hourly rate for every hour saved.

A slight modification of this system consists in increasing the premium to one-half the hourly rate for every hour saved. It is sometimes called the Halsey 50 per cent system.

Under the Halsey system, as now generally understood, a certain length of time, called a time limit, is allowed for the performance of each job; and the employer agrees that this time limit will not be changed so long as the method of manufacture, under which it was fixed, continues the same. The workman is, further, usually guaranteed his regular hourly rate for the time spent on the job; and if he completes it in less than the specified time, he receives an additional amount as premium, equal to his hourly rate multiplied by one-half the time saved. The employer and the workman thus have an equal share in the direct profits.

Another premium system is that known as the Rowan system. Under it, as under the Halsey system, a time limit is set for the performance of each job, the workman receiving his hourly rate for the actual time spent on it; but, unlike the Halsey system, wherein the premium is based on one-half the time saved, the premium here consists of a percentage of the allowed time. And when this has been said, one of the drawbacks to the system has also been mentioned, since it is not easily understood by the workman. For example, if the workman performs a job in 25 per cent less time than the time limit, he receives his hourly wage for the actual time, plus a premium equal to 25 per cent of it.

One of the most novel premium systems is the Santa Fe, in use on the Atchison, Topeka & Santa Fe Railway.

To set any time limit intelligently, the theoretical

minimum time in which the work under consideration can be performed must be known very closely. This minimum time is then usually augmented to such an amount as will enable any skilled workman, when working as he ought, to perform the work regularly within such time. The period of time thus arrived at becomes the base or standard time of the system. If the work is completed either within or even in excess of this time, a bonus or premium is awarded. Figured from the base time, the bonus or premium increases with decreasing time and decreases with increasing time until at some percentage in excess of the base or standard time, known as the time limit, it disappears entirely, the workman then receiving but his hourly rate for the time spent on the jub.

If the job is performed in exactly the standard time, the bonus or premium amounts to twenty per cent of the regular wage; if the job is performed in less than the standard time, the workman receives the entire wage the employer would have paid had the work been completed in exactly the standard time; if the time required to perform the job is in excess of the standard time, the day work rate is still paid, plus a bonus or premium, which, however, decreases rapidly (according to the parabolic equation) with increase of time, until a point is reached where this excess amounts to fifty per cent of the standard time, when the bonus ceases.

As in most other premium systems, the workman is guaranteed his hourly rate. It is difficult for the average workman to understand the basis on which the bonus or premium is figured when the job is completed in excess of the standard time; but, as this applies to only a small percentage of the work, the objection is not a serious one.

To compare properly the several premium systems described, it is necessary to assume that (a) the base or standard time is the same, (b) the day rate is the same, (c) in the Halsey and the Santa Fe systems, the total wage or the wage plus the bonus or premium, is the same when the work is done in exactly the base or standard time, (d) a bonus of twenty per cent added to the wage when the work is done in standard time, as is the rule of the Santa Fe system, will in the Halsey system correspond to an incentive of forty per cent added to the base time (instead of the customary fifty per cent), (e) in the Rowan system the time limit is the same as in the Halsey system.

From the employer's point of view, the Rowan system is applicable to classes of work where, owing to lack of complete data for estimating the length of time required for jobs, neither piece work, the Halsey nor the Santa Fe system would be so suitable; for there is minimum danger of exorbitant wages from inaccuracies in setting time limits. Criticism has been made of this system that the interests of the employer have been so fully conserved in the setting of these limits as practically to take away all incentive from the workman to exert himself beyond time and one-half. It is argued, on the other hand, that Rowan's system gives the man an increase of wage equal to the saving effected from the time limit. However, this argument has not at present the same force, for if any premium system is to be successful, a time limit once set should not be altered so long as the method of manufacture remains unchanged.

The Santa Fe system, distinctly a premium system, more nearly approaches piece work than either of the other two methods. Practically all of the direct profits go to the workman, the employer benefiting only in-

directly, as in piece work, through a reduction in the general or indirect expense.

The Halsey system may be considered as occupying a position intermediate between the Rowan and Santa Fe systems. Compared with the Rowan system, it pays rather less for the same effort up to time and one-half; but beyond this point, the condition is reversed and it then pays more. If the time limits were laid out on a basis of the average workman making time and one-quarter, the Rowan system would be more attractive from the workman's standpoint.

As, however, the schedules are usually more liberal, at least in this country, the average workman making, say, time and one-half, while the more expert exceed this considerably, the Halsey system has the advantage from the workman's standpoint, but it is not so advantageous from that of the employer. Compared with the Santa Fe system, the Halsey system pays less for the same effort at nearly all points, and for this reason would appeal less favorably to the workman, but more favorably to the average employer, particularly to the one whose products are diversified, and the time limits on which are accordingly more liable to inaccuracies than when the products are fully standardized.

MODERN *payment plans devised by F. W. Taylor, H. L. Gantt and Harrington Emerson are based on the philosophy underlying the new science of management.*

Philosophies of management really underlie the more modern methods of wage payment formulated by F. W. Taylor and others. Impressed by the natural tendency of the workman to do as little as possible under the ordinary day wage, and equally realizing the folly of the employer to set a piece rate and cut it as soon as the

workman begins to make more than he thinks he should, Mr. Taylor made scientific studies to determine exactly what a normal day's work for the ordinary man is. In order to induce men to accomplish this normal day's work he also devised the differential piece rate, which he described as follows in a paper before the American Society of Mechanical Engineers:

"This consists briefly in paying a higher price per piece, or per unit, or per job, if the work is done in the shortest possible time and without imperfections, than is paid if the work takes a longer time or is imperfectly done."

Standardizing operations, therefore, and setting an attractive wage for the workmen who accomplish the operations on time and produce perfect goods—these are the methods adopted to secure maximum efficiency in workmen.

For example, it may be found that fifty pieces of a certain article constitute the normal number which a man can do in a day without over-working himself, yet without "soldiering." The piece rate may be set at seven cents for the man who succeeds in turning out fifty perfect pieces, making his day's pay $3.50. If, however, he can not do the required amount, but turns out only forty-five pieces, the rate per piece is somewhat lower, say six cents, making his wage $2.70. If he makes the full fifty pieces, but some of them are imperfect, the piece rate is still lower, say only four or five cents, making his day's pay $2 or $2.50, as the case may be.

This system, therefore, put a big premium on the full day's work, on work that is perfect, and guarantees high wages to the workman who proves his efficiency. The day's work is no greater than a thoroughly well-trained workman can accomplish, and every means

is taken to give men thorough instruction in the one best way to do their work.

The same scientific planning and timing of operations forms the basis of the payment system proposed by H. L. Gantt and very successfully used in various plants. In this method, known as the task and bonus system, the workman is given a task, and everything is arranged, tools prepared, and instructions given, so that he may be able to accomplish the task in the allotted time. He is guaranteed regular day wages whether the work is finished on time or not, regardless also of whether it is perfect or not.

If, however, the work is done in the allotted time, and is perfect, the workman receives a large additional bonus, which in practice amounts to about twenty to fifty per cent of his regular wages. This plan, therefore, has the advantage of assuring the workman of a fair day's wage, even if he can not for any reason accomplish the task set in the allotted time. While the differential piece rate is peculiarly valuable in the case of work which is largely repetitive, the task and bonus system can be used to advantage where the work varies from piece to piece or job to job.

The "efficiency plan" of Harrington Emerson is much like the task and bonus system, except that the workman begins to receive some extra reward even before he has accomplished the standard day's work. Thus, if he succeeds in doing the allotted task, he receives a twenty per cent bonus over his guaranteed day's wage; but if he performs only two-thirds of the task, he receives a small bonus, which increases by a graduated scale the nearer he approaches a full day's work.

In all these systems the aim is to secure a full and efficient day's work from the laborer. He will not work

to the extent of his powers, even on piece work, if he knows that so doing will mean a cutting in his wages as soon as he has earned a little more than his employer thinks he should. The right wage system, whichever one you choose, must have as its foundation your firm determination to be absolutely fair to your employees. Cooperation, not slave-driving, is the essence of the new philosophies of management which have introduced payment methods making for efficient production.

NOT *only is the shop pay roll generally the largest single item of manufacturing cost, but it is an item which varies because human nature varies. Behind each precise total on the pay roll, is the story of the man's work on each job. And an analysis of the pay roll, consequently, is very often the interesting study of men's motives in doing work. Any manager who hasn't looked back of the total in each pay envelope not only has failed to make the most of his pay roll, but has missed an opportunity to get in closer touch with his workmen.*

—S. D. Rider

Vice-President, South Bend Watch Company

XV

APPRAISING WORK BY TIME STUDIES

By Frederic G. Coburn
Assistant Naval Constructor, U. S. N.

ALTHOUGH the factory manager untrained in the development of scientific management cannot himself apply its principles to their full extent, says F. W. Taylor, he can accomplish a great deal to better the conditions of ordinary management.

For just as the doctor is at an utter loss until he makes his diagnosis, so the manager, in starting to better his management, must likewise diagnose conditions in his shop. For this he has one extremely useful instrument—the time study; by its use he can learn his factory's weak points, see the method of attack, and constantly keep himself posted as he proceeds with the development.

In its full sense, the time study involves the analysis of a job into its constituent operations; the study of the equipment used, and of the methods of several of the best men; the building up of the best adjustment of equipment, and the best methods into the "one best" method; and, finally, the careful speeding of the man in this best method. Thus, the result of a time study is a composite of the best ideas in use when the study is made, plus new ideas suggested or developed in making the study; a close adherence to any one man's methods is, therefore, generally dangerous, for it is almost in-

variably found that the best method is never in use.

It is evident that to realize the full value of time study, great skill and experience in obtaining best methods, an organization of high character to apply them is needed. But, in the preliminary work, such refinement is unnecessary—even inadvisable. An approximate time analysis of what is actually going on will point out the delays and mishaps, indicate the lines of general betterment, cause considerable improvement in the detail operations studied and provide valuable data for scheduling and planning work. As will be at once realized, a first-class time-study man is a high-priced man. But, again, for this preliminary work, a man totally inexperienced in time study can be advantageously employed; if he is carefully trained he will be able to do the high-class work when the time comes.

CHOOSING *the right man to make the time study—how to analyze operations, record them graphically and find from them the standard "one best" way.*

For this detail it is extremely unwise to pick an assistant foreman, or other man employed in a supervisory capacity, as such men are usually in their jobs because they have shown executive ability, and such ability is not requisite in a time-study man. It is equally unwise to pick a man from the clerical force, for, unless he is a former mechanic, he cannot understand the work he is studying. The man detailed for this work must be relieved of all other work if he is to do it properly.

A bright young draftsman, with previous mechanical training, or at least a good working knowledge of factory processes, is good timber; so, also, is a well-educated mechanic. A somewhat analytical and skeptical turn of mind is a valuable asset.

Among the first things to be found are delays due to lack of instructions and drawings, lack of tools and material, or faulty tools or material, machine mishaps and belt failures. It is not easy to trace these troubles without training in discovering them, because they are so common that they cause no comment. But if one particular man or job be studied, these things will come to light and show the track to be followed.

Perhaps the most elementary form of study and, therefore, the best to begin on, is this study of one particular man's doings for the working day. In one instance, such a study made of a drop forger, resulted in increasing his efficiency about 200 per cent by simply eliminating delays.

Suppose a blacksmith is to be studied. The first step is to set down what he does in a day. Thus, his time is consumed as follows:

Operation	Code Letter
Actual forging	F
Waiting for heat	W
Waiting for hammer	A
Waiting for helper	M
Waiting for material	J
Waiting for instructions	T
Receiving instruction	
Mending fire	
Fixing tools	
Time lost . . M, A, J and T	

For this sort of study it is sufficient to record times to the nearest minute. An excellent way to record such a study is to use an ordinary notebook of cross-section paper, heading the columns with letters to indicate the element represented by each column and taking each vertical space to represent a minute of time. Figure

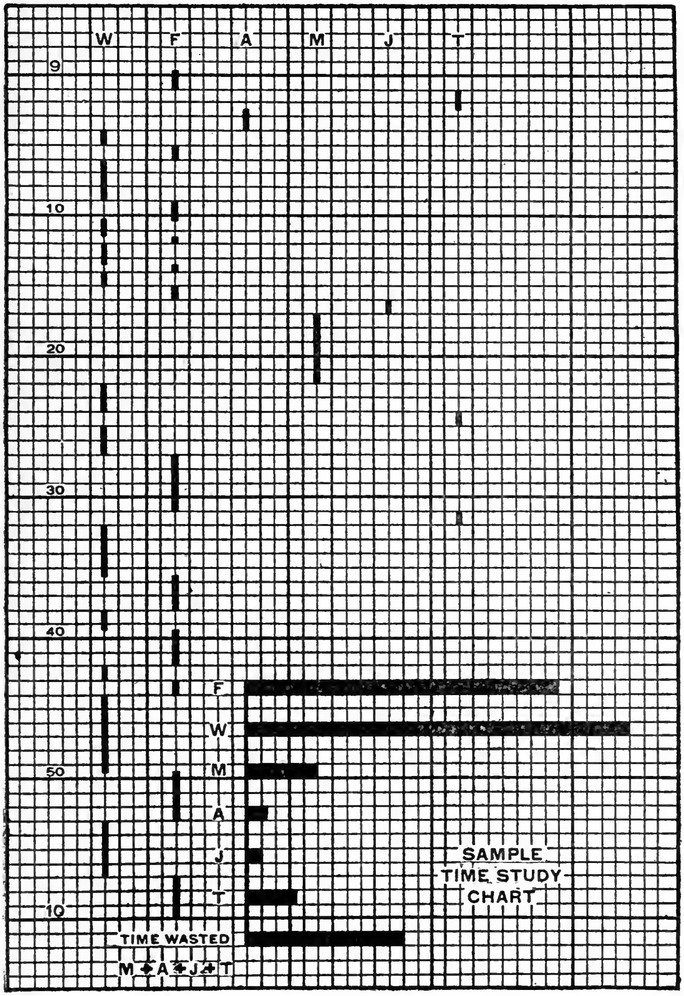


FIGURE XIII: This chart showed just what occurred during each minute of one hour. At the bottom the recapitulation shows such relations as work to time wasted, work to useless energy, and points out unnecessary wastes

XIII is a reproduction of such a sheet for a portion of a day; it indicates the method of scoring—running the pencil down the "Forging" column, for instance, until the work goes into the fire, then shifted over into the "Waiting for Heat" column until the next move is made, and so on.

After a few hours' practice it will be found possible to study several men simultaneously. This is valuable, as it precludes the danger of an "exhibition run." Real conditions will be learned when there is no knowing who is under observation.

Graphic summaries of these studies are the most striking. They may easily be made by preparing a chart consisting of horizontal lines starting from a common vertical line proportional in length to the sum of the times they represent. The illustration, Figure XIII, is summarized for the period of time it covers.

These simple studies point the way to improvement in the methods of assigning work and giving instructions, providing material and tools, caring for machinery, and so on, and provide data for starting the planning or routing work.

The study of a particular job is the next step. A representative job may be taken, analyzed into its constituent operations, and followed through the shop from the time it first lands on the floor until it is done. This throws light on the general conditions from a new angle; it tests the factory arrangement, means of transport, provision for inspection, and so on, and provides valuable information for use in scheduling the work. In applying the lessons of these studies, the plant as a whole is speeded up, with a beneficial result to the work in progress.

This method of study, besides affording valuable

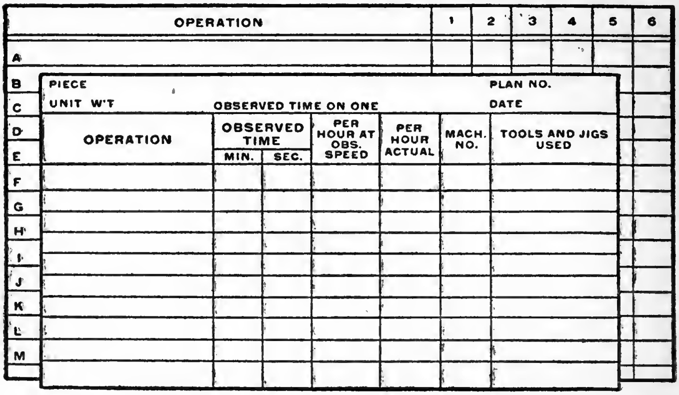
data for systematizing material transported, arranging the shop and scheduling work, will show where the first machine operation time studies should be made—the longest and most expensive ones offer the greatest chance for saving and should, therefore, be the first attacked.

When ready to take up the study of such a machine job, the first step is to analyze it into constituent parts, or operations. For this early work it is not necessary to get down to such fine points as separating the chucking operations, for example, into picking up, setting on the table, placing dogs, centering, securing dogs, and so on; it is enough to deal with the major operations, as, for example, to chuck, set the machine, take roughing cut, take second cut and remove work. Troubles enough will probably appear to make further refinement at this point inadvisable. Times should be taken, however, in minutes and seconds, using a stop watch.

For these studies a card like Form I is useful. The reverse side of the card is used to record all the conditions in the job; to show how far the work has been carried, when the study began, how the machine was set, speed, feed, cut, kind of tool, and so on, and such other points as have a bearing on the time of workmanship as, for example, whether the tool was water cooled, oil cooled or dry, whether belt slipped or not. On the reverse side of the card the operations are set down in their sequence.

It will be noted that the card is arranged for six studies of the same operation under a single set of conditions. This helps to preclude misleading figures due to "exhibition runs," insures the inclusion of delays between successive operations, shows the effect of waste motions in varying the times on identical operations, and emphasizes machine, belt and tool troubles.

For purposes of comparison and further study, make similar studies of the same operation under the same conditions; then, without going too deeply into the machine study, some changes can be made which will



OPERATION	1	2	3	4	5	6
A						
B						
C						
D						
E						
F						
G						
H						
I						
J						
K						
L						
M						

PIECE PLAN NO.

UNIT W'T OBSERVED TIME ON ONE DATE

OPERATION	OBSERVED TIME		PER HOUR AT OBS. SPEED	PER HOUR ACTUAL	MACH. NO.	TOOLS AND JIGS USED
	MIN.	SEC.				

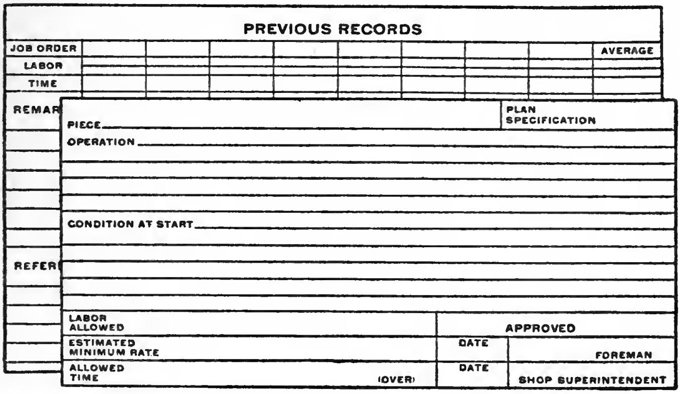
FORM I (front card): Card used in timing a machine job. FORM II (back card): When operations have been studied, this card is used to record the "one best" method

improve times. Further studies and synthesis will result in a very much improved method, which can be built up and recorded on a card similar to Form II, and this new method adopted. This is the first step toward standard practice; it must not, of course, be considered as final—it is not profitable in the early stages of development to arrive at anything final; the object is to advance the whole plant, step by step, toward a maximum efficiency.

It will be noted that cards like Forms I and II are helpful in the second form of study—that of studying the particular job throughout the factory. Form I is adaptable to the preliminary repetitive study; Form II

to the preparation of the record. The condensed information in Form II is particularly helpful in developing a planning department.

After having developed an improved method for a given job, and passed on to other problems, means must be provided for holding up the standard thus set, lest the work advance on the plan of three steps forward and backslide two. This can be done, when the planning department is sufficiently developed, by a continuing record similar to that shown in Form III, which is a combination rate card and continuing record used in connection with a premium plan of payment in a shop at the Mare Island Navy Yard. All details of the opera-


PREVIOUS RECORDS
JOB ORDER
LABOR
TIME
AVERAGE
REMAR
REFER
PIECE
PLAN SPECIFICATION
OPERATION
CONDITION AT START
LABOR ALLOWED
APPROVED
ESTIMATED MINIMUM RATE
DATE
FOREMAN
ALLOWED TIME
(OVER)
DATE
SHOP SUPERINTENDENT

FORM III (front and reverse sides shown): This is the card used for continuous records to insure that after the improved method has been found it will be maintained

tions, condition at beginning of operations, class of labor, time allowed, references to time studies, plans and a continuing record of this particular operation are afforded to judge of the accuracy of the time allowed,

and of the regularity with which the time is attained.

When your time studies have been tested and your improved methods are in working order, you will be astonished to know how much the haphazard setting of tasks has cost you in the past in the way of labor not up to the right standard of efficiency.

THAT *the first-class man can do in most cases from two to four times as much as is done on the average is known to but few and is fully realized by those only who have made a thorough and scientific study of the possibilities of men.*

—F. W. Taylor

Author, The Principles of Scientific Management

XVI

PAYING MEN BY THE DAY

By H. J. Minhinnick
Civil and Electrical Engineer

TO SECURE records of labor on day-work jobs, to avoid inevitable mistakes made by foremen with time books, and to do away with the great amount of work ordinarily necessary the last of each week in compiling a payroll—these are the points that must be considered in devising a practical timekeeping system.

One concern has adopted a system which satisfactorily covers all these points. Not only does it do away with troublesome details in handling men on contract jobs, but it has also been adopted in a number of factories in which the product is substantially uniform. It can be used in a factory which does not require a job ticket system for getting costs on work.

As it is applied in contracting work, the jobs to be done on a contract are divided into four sections: "Wiring," "Cables," "Poles" and "Subway." Each of these different divisions is subdivided as far as necessary in order to get accurate costs on jobs. For each division a time ticket is made similar to that shown in Form I. The cards for "Wiring," "Cables" and "Poles" are printed on different colored papers so that they may easily be distinguished from one another. The "Subway" time tickets are printed on a stiff manila card, owing to the use to which they are put.

When a man starts working for the company, he is assigned a number and given a button on which his number is stamped. This button he must wear continuously while he is at work. Each foreman is given a punch of distinctive pattern so that his punch mark constitutes his signature. With this simple equipment accurate time records can be kept.

To take a concrete example, John Smith is hired in the "Pole" department at $2.00 a day. He is given button "No. 127." He begins work at "11 a. m.," and is employed in unloading poles from 11 to 12 a. m. and in shaving poles from 1 to 5 p. m.

When the foreman gives this man his button he also makes out a ticket for the workman similar to that shown in Form I. First, he enters the man's name; second, he punches the rate per day; third, he punches the hour at which the man commences work; fourth, he punches out the number (127) by which the man will subsequently be identified. At quitting time he punches out one hour under the "Unloading" subheading and four hours under the "Shaving and Framing" subheading. Had John Smith been continuously engaged in shaving, the foreman, of course, would have punched out five hours under that division on the card.

If John Smith works the next day, it is to be noted that the first three operations are dispensed with entirely. All that it is necessary to do is to punch out the man's number and his time.

At the close of each day's work the foreman is required to place all the tickets for the crew in a single envelope and turn this envelope in at the office. In making out his tickets, if it is necessary to work overtime, provision is made for this on the form; while if the man is to quit work, the foreman punches the pay-

OFF	PAY	1/2	10	9	8	7	6	5	4	3	2	1	OVERTIME

TIME CARD

TIME STARTED	7	8	9	10	11	12	1	2	3	4	30

RATE PER DAY			WORKMAN'S NO.					
3.00			100	106	112	118	124	130
2.00	.90	.40	101	107	113	119	125	131
1.75	.80	.30	102	108	114	120	126	132
1.50	.70	.20	103	109	115	121	127	133
1.25	.60	.10	104	110	116	122	128	134
1.00	.50	.05	105	111	117	123	129	135

POLES

NO. OF HOURS	UNLOADING		SHAVING AND FRAMING		LOADING AND HAULING		DIGGING HOLES		SETTING POLES		GUYING		PINNING AND BRACING ARMS		ATTACHING CROSS ARMS AND STEPS		DOUBLE ARMING			
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4
	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6
	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8
	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10
	0	1/2	0	1/2	0	1/2	0	1/2	0	1/2	0	1/2	0	1/2	0	1/2	0	1/2	0	1/2

FORM I: When he goes to work, each man receives a ticket like this, with his starting time punched in. It is turned in and again punched by the foreman when he stops

off square on the form. The data afforded by the tickets are then immediately transferred to the payrolls.

Four payrolls are ruled out for each week. The headings on these payrolls are the same as those which appear on the tickets, so that on each payroll are summarized the forms and records that come in each set of tickets. This simplifies the clerical work on pay-day.

For example, under John Smith's record on this payroll, the record would be as follows: No. 127—John Smith—on Monday 25 cents charged to unloading poles, \$1.00 to shaving and framing; on Tuesday \$2.00 charged to shaving and framing, and so on, for the balance of the week. Thus it is seen that the time is recorded in dollars and cents and not in time each day. Consequently, the vertical footings give the various costs charged to, and the horizontal footings the amount due each man, while the sum of the vertical and the sum of the horizontal footings on each payroll sheet must be equal. Incidentally, this proves the payroll. On payday it is a very simple matter to make the cross footings and draw the checks.

As was noted in an earlier paragraph, the "Subway" ticket is printed on a heavy manila stock. While the operations are the same on this ticket, the actual working routine in connection with it differs from that followed in other cases. When the man goes to work in the morning the ticket is given him (this is the reason why it is printed on heavier stock), and the workman keeps it until he quits. When he receives the ticket it is perfectly blank; consequently, no time is lost in distributing the cards. Just before noon the foreman punches the man's number and his "a. m." time under the proper heading or headings and returns the card to the workman.

Just before quitting the foreman repeats the operation for the "p. m." time and retains the cards. In this way the workman practically keeps his own time, while the foreman has an opportunity to check the record. In actual practice it has proved that the workman is very careful to see that there are no mistakes made in his timekeeping. He makes sure that he gets a time ticket when he starts on the work and that the foreman punches his time on it correctly.

It is this "Subway" card which is applicable in industrial plants and which, with proper modification of headings, can be adopted in almost any manufacturing or contracting business. In our contracting business the cost data which appear on the payrolls are transferred to the cost ledger, which thus shows week by week the exact labor cost of every detail.

THE *organizing executive must have a knowledge of men exactly as the mechanical engineer must have a knowledge of materials and mechanics. The right men must be selected, trained and fitted into their proper places in this vast industrial machine, and these men must have in their make-up a harmonious blending of science, practice, and, in addition, commercial efficiency.*

—James Logan

Chairman Executive Board, United States Envelope Company

XVII

PAYING MEN BY THE PIECE

By J. Eddy Chace

PIECE rates set in the old way are founded on an unknown quantity at the very start. As a result, it is a common thing for a man to say: "Yes, we do piece work and I make from four dollars to five dollars a day and sometimes I have three or four days' work stored away out of sight under the bench that I keep for rainy days, when I turn it in a little at a time. It's a snap, and I could make seven dollars and fifty cents a day if I wanted to, but, of course, I don't want the price cut down, so I have to go easy."

This is one of the conditions which the scientific study of piece rates meets successfully. For, outside of the apparently liberal reward, the chances are much against such conditions existing under the scientific method, which requires an accurate time study, the determination of a large daily task to be completed by a first-class man under standard conditions, for a large reward in case of success and a loss in case of failure.

Setting rates which bring such results seems to many, perhaps, to be too much like the ideal, and surely more expensive than they are worth. But it is being proved in several factories today that this ideal is practicable, and that the best permanent results can and are being obtained by scientific study of work.

The work that goes with the introduction of new wage systems is something everyone doesn't wish to undertake, but it is an interesting task, nevertheless. The study of human nature is the big factor, and you can never tell just what the workman will do or say for or against any new plan affecting him personally. The management, of course, can see the advantage of reduced costs, the investigator knows that in the end the workman and his employer are both to benefit, but to persuade a man to change his way of doing things is a problem that surely calls for a knowledge that isn't to be gained by a study of books or articles.

HOW *to find the standard way of performing each operation—training the workman to follow it, and setting the piece rate which is equitable.*

Yet, the actual experiences in this factory may prove of value and of interest in pointing out some of the steps necessary when the average manager undertakes to introduce scientific methods of setting piece rates. Time and money must be spent in studying all the conditions affecting machines and men, many details worked out before time studies are made.

The difficult and vital part of such a plan is the selection of the workman whose output is to be studied and taken as a basis for a daily task. So much of the later result depends upon this choice that you must make it a point to study and to talk to a number of the best men employed in one class of work, finding out their ability and attitude toward the proposed changes before attempting to select a man to do the work, and then find yourself dissatisfied with the results, and have to try some other until the standard can be fixed correctly.

A great many times it is impossible to locate a man whom you feel sure can do the work in the best way. This necessitates the training of some one by the investigator. Oftentimes it is best to learn to do the work yourself; and then, having mastered the operations and reduced the motions called for to the least number possible, have the workman watch you. He will soon better his old schedule.

Having selected the operator and some part that is to be put upon piece work, at the very outset make a study of the condition under which the work is being carried through on the old methods. On entering the department, perhaps, ask your man what he is working on and remark that you have been waiting for that order to come along, so you could see just what could be done with it. Watch him do the work in his usual way and make no secret of the fact that you want to find out all there is to be known about the different operations. Talk over the work with him, find out just how accurately he finishes the piece and if the castings vary from time to time.

Then examine the jigs or appliances used to hold the work, and if there is any new machine more suited to the work, or any improvement possible, talk the matter over with the foreman in charge, and then proceed with the proposed changes.

Satisfied that the part is being handled properly as far as tools are concerned, make a study of the tool speed to determine the revolutions and feed at which the different tools act. If these can be changed to advantage, try it out. Oftentimes it is necessary to go back to the old speed, but at other times a big saving can be accomplished.

In one case, where a great number of small cast iron

gears were being bored out, the drill was formerly operated at two hundred and seven revolutions per minute, a speed adapted to the ordinary carbon drill rather than to the expensive high-speed drill in use. When this speed was increased to three hundred and seventy revolutions per minute the workman almost refused to do the work, saying that the drill would turn blue in two minutes. A number of months have gone by and the workman, now on piece work, is boring those same gears at a big reduction in cost.

When the tools are as near standard as possible under existing conditions, return to the workman, suggesting to him that he get his material close at hand so that he won't need to reach in any direction further than is absolutely necessary. Pieces formerly thrown or laid here and there are put upon a table, a half dozen at a time, instead of being reached for, one at a time. This saves time and effort which, if applied in a different direction, helps to get out a few more pieces in a day.

In all of this time study, it is a good policy to impress the workman with the fact that you are getting the work thoroughly in hand, so that he can make extra wages easily and surely. He must be made to see the advantage to himself in following instructions.

With your data at hand, it is easy to figure the day's work and the price that must be paid. With different classes of work the extra amount necessary to induce men to do more may vary from twenty-five to one hundred per cent. One class of help is satisfied with twenty-five to thirty-five per cent increase, so that an addition to the day wage of this amount can be taken as the new wage. Having the time allowed for a certain piece, as ten hours for four hundred pieces, and a day wage of twenty-five cents per hour, the piece price per one

hundred can be determined by adding, say twenty-five per cent to the day wage, which would make three dollars and twelve cents, and dividing this by four to obtain seventy-eight cents per one hundred as the price to be paid.

The standard in this case is forty pieces per hour, and the workman knows that he is expected to do this amount. If it is possible for him to do more than this, he gains in proportion, but for a continuous thing the task set should be all that is required.

For the reason that during short periods of time almost anyone can do a greater amount of work than usual, it is often necessary to ask the operator not to overdo himself. Many times it is said that piece work is too much for the workman's health. Under some conditions this is no doubt true, but the real aim is to have the operator work steadily, not at the pace that kills, and make every move count for something accomplished. If he will do this there is no occasion for complaint. He seldom falls below the requirements.

HIGHER *wages mean reduced costs only when production is increased more than enough to cover the increased cost. As a rule, every workman is waiting for an opportunity to enlarge his income, and will almost invariably do more work for an increase in pay. Not only will he do more work under the efficiency plan, but he will do it better and easier than when he was left to teach himself.*

—F. M. Feiker

XVIII

PREMIUM AND BONUS SYSTEMS

By W. Poole Dryer
Managing Director, The W. Poole Dryer Company

IN EVERY factory there are certain jobs which sooner or later the manager considers putting on a piece-work basis. Under the ordinary time-payment plan all the proceeds of the workmen's labor above the amount gained by the man who simply "holds down his job" go to the employer. The day-work method of paying men is defective because it does not penalize indifference.

Piece work, on the other hand, often fails to produce maximum output, for two reasons. The employer fixes the limit with the possible total wage, or more generally establishes a bad precedent by cutting the piece rate when he thinks the workman is earning too much. Piece work, therefore, is ever watched suspiciously by the workman and is a frequent source of strife between employer and employee.

Piece work certainly allows a man to gain something in personal efficiency and allows the employer to know definitely the labor cost per piece. But because of the abuses to which it is open, men in general take good care not to "spoil the job" by doing more than what the short-sighted management has fixed as their maximum output. Piece-work wages are attractive to the average factory manager because of their simplicity.

It is an easy matter to count the number of perfect pieces a man has made and multiply this figure by the price per piece agreed upon and so compute the weekly wage of the workman. If a piece-work system is carefully arranged—if prices are established after a long experience with the article to be manufactured—if there is an honest endeavor to give the workman his fair share of the benefits, the piece-work system can be put into effect with little friction.

But because of the disadvantages of both the wage and piece-work systems, the management of an automobile concern applied a premium system to their factory.

HOW ***a British concern applied a premium system of wage payment with the result of increasing output and the individual employee's wages at the same time.***

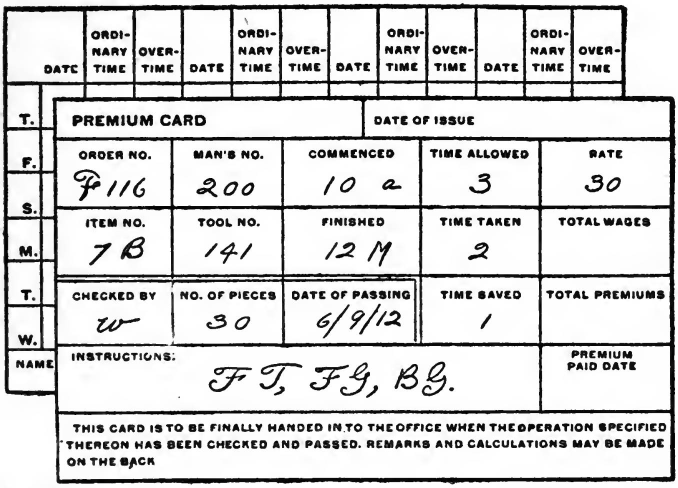
The principle of the plan is simple. Suppose that the average man can complete a certain piece of work under average conditions in one hundred hours. This is taken to be the standard time for the job. If the workman succeeds in turning out a piece in eighty hours he receives payment for the eighty hours at his ordinary rate and is given in addition a premium equal to 20/100 of his hourly rate for the time worked. Thus, if a man's rate was fixed at thirty cents an hour, his pay for the eighty-hour job would be $(80 \text{x} 30) + 80\ (^{20}/_{100} \text{x} 30) = \$28.80$.

Suppose the conditions to remain the same: if a man had been turning out that piece of work in one hundred hours on the day-work basis he would receive $100\text{x}30 = \$30.00$ for the work. On the premium basis he receives \$28.80; consequently, the cost of that work to the employer is \$1.20 less. The time taken is re-

duced one-fifth and the workman, consequently, will turn out more in a given time and so increase his total wages per week.

The firm, of course, gets also greater output of work at proportionately less overhead expense for each job. Even if the time estimates were so great that a man could complete a job in one-half the time estimated, say in fifty hours, his total wages would be less than double time.

The management of this factory, however, agreed that unless new machinery or new methods were introduced



	DATE	ORDINARY TIME	OVERTIME	DATE	ORDINARY TIME	OVERTIME	DATE	ORDINARY TIME	OVERTIME	DATE	ORDINARY TIME	OVERTIME
T.												
F.												
S.												
M.												
T.												
W.												
NAME												

PREMIUM CARD			DATE OF ISSUE	
ORDER NO. F116	MAN'S NO. 200	COMMENCED 10 a	TIME ALLOWED 3	RATE 30
ITEM NO. 7 B	TOOL NO. 141	FINISHED 12 M	TIME TAKEN 2	TOTAL WAGES
CHECKED BY W	NO. OF PIECES 30	DATE OF PASSING 6/9/12	TIME SAVED 1	TOTAL PREMIUMS
INSTRUCTIONS: F T, F G, B G.				PREMIUM PAID DATE

THIS CARD IS TO BE FINALLY HANDED IN TO THE OFFICE WHEN THE OPERATION SPECIFIED THEREON HAS BEEN CHECKED AND PASSED. REMARKS AND CALCULATIONS MAY BE MADE ON THE BACK

FORMS I and II: Here are shown the front and reverse sides of the time card used for assembling by order number the labor cost under the premium plan

the time once set would never be changed. Consequently the men work with the assurance that they will be allowed to earn as much as they can. Moreover, their weekly wages are assured and no debt is run up against them.

Before the system was installed other factory systems were studied.

In one factory where the premium plan was applied, careful records showed that the premiums paid had a tendency to increase. In fact, the proportion of the premium to the normal wages was looked upon as a test of the efficiency of the works and individual workmen. The ratio of premiums to wages paid to men working on the system one year averaged nine and five-tenths per cent; the next year it had risen to fourteen per cent; the third year to twenty-one per cent, while in the fourth, a year in which much overtime was required, it fell nineteen per cent. From the beginning of the installation of the premium system in this plant men on premium work have earned an average of sixteen per cent more than their hourly rate.

No attempt was made to introduce the system into the automobile plant bodily. Instead, a few jobs were first chosen, and gradually one job after another was put on the premium basis. The method of computing the time of assembling is shown in Forms I and II.

A machinist is given half a day to bore cylinders and told that the premium time is four hours per cylinder. When the work is given out a boy in charge fills out the card for the work, on which is stated the time at which the work commenced.

No inconvenience is caused by having to lay aside the work for other more pressing, for the time spent each day on this operation, "Boring Cylinders," is recorded on the calendar on the obverse side of the premium card.

Every morning the cards representing finished operations are turned over to the premium clerks in the timekeeping department who check the total time on

each man's premium card with the time punched on the clock cards.

The cards are then passed on to the cost-keeping department where the details are entered on "comparison cards," which record the time spent on each operation of each piece of work. The cards representing unfinished work are returned to the factory until the particular jobs are completed.

When filling out these comparison cards, the clerk lays aside for investigation all premium cards showing excessive time periods. By this means a check is put on inefficient methods of manufacture and also on the delinquencies of the workmen. In order that these leaks may be properly located, it is essential that the cost department pass the premium cards the day after the completion of manufacture of each item. Otherwise the foremen and workmen cannot be expected to recall the details experienced in the production.

The premium cards are then returned to the timekeeping department, where, at the end of the week, the total premiums for each man are added. On account of the time involved in checking and investigating the premium time periods, the workman usually does not receive the premium until the week after he has earned it. Then it is paid along with his regular time wage in the usual way.

Systematic throughout, this company carries out the payment of the men on Saturday in a business-like manner. Instead of merely putting the man's pay in the envelope, and making his guess how much is bonus and how much straight time wage, an explanatory slip is enclosed along with the money. An adding machine is used to make up the weekly payroll. After getting the total weekly cost of labor, the strip from the machine is

cut into slips and these are put in the men's envelopes.

As in all piece-work and premium plans, a vigorous method of inspection of finished work is a necessary adjunct. The workman has a tendency to increase output at the expense of quality. "Scamping" is effectively eliminated by testing all work by "go-in, no go-in" gauges.

As an attempt to extract the maximum return out of capital invested in machine tools, the premium system in this factory has proved an economic success, increasing the earnings of both employer and workmen.

MONEY *spent in properly studying processes and training workmen brings a return far in excess of any other investment, for not only is the wage cost per piece often cut in half and the output doubled, but the increased output is often had with practically no permanent increase of "overhead expense."*

—H. L. Gantt

Consulting Engineer

PART IV—GETTING OUT THE PRODUCT

Keeping up with Demand

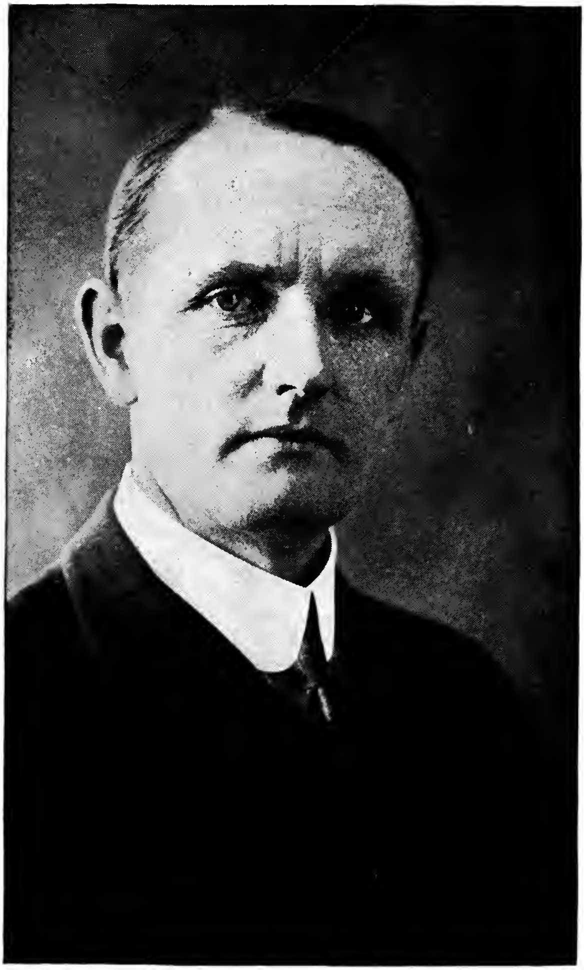
TO serve the public means much more in the public mind than it did a few years ago. Continued success in manufacturing and selling comes from simply this—successful public service.

In many lines of manufacture it is necessary to order materials far ahead of the consummation of the sale of those materials in the finished product. The dealer is close to the public. His customers have confidence in him. It is the dealer who first senses a growing public demand and charts its course.

The dealer, then, is the connecting link between the manufacturer and the consumer. Upon the dealer rests the responsibility not only of serving the public today, but of anticipating the public demand of tomorrow so that it can be met squarely through complete cooperation with the manufacturer.

Absolute confidence is, therefore, necessary between the manufacturer and the dealer. The manufacturer can not sell service without the thorough cooperation of the dealer and that cooperation can not be maintained without continuous fair treatment of the dealer and—through him—of the consumer. Commerce today, instead of following the harsh rule of "let the buyer beware," follows the Golden Rule: generally accepted, and better known, as the Square Deal.

Walter Davidson



WALTER DAVIDSON

President and General Manager, Harley-Davidson Motor Company

XIX

PLANNING AN ORDER SYSTEM

By Fred Biszants
Formerly Superintendent, The Gramm Motor Truck Company

TWO classes of manufacturing orders are issued to our factory—production orders for stock, and orders to assemble. These orders are issued on a schedule basis determined by the management. A quota for each month, three months in advance, is set for each model. This quota is based on information from the sales department which sends to the production department not only a list of advance requirements, but complete specifications of those requirements and the shipping dates. The production system is designed to insure the fulfillment of the schedule dates and quantities.

Production orders for stock to be made, and for parts to be bought to "stock-up" in order to meet the schedule requirements, are issued by the stock department. This department issues for this purpose production orders and purchase orders.

Production orders (Form I) are printed in quadruplicate, the first three on white, yellow and pink paper, the fourth, which eventually becomes the foreman's work record, on cardboard.

The first and fourth copies, the white and the cardboard, are sent from the stock office to the planning department. The second, or yellow copy, goes to the cost

department after the data thereon has been entered in the permanent records of the stock office. The third or pink copy is forwarded to the production department.

After the planning department has completed its work with the white and cardboard copies, they are sent to the office of the general foreman of the department concerned, together with the route or schedule card as described below. The cardboard record is placed on file in the office of the foreman for record. The white copy, together with the route or schedule card mentioned, is sent to the rough stock room and acts as a requisition for the raw material which is required for the order. As soon as the material specified is delivered to the department requiring it, this white copy is returned to the stock office and a record made of the material charged against the order.

PLANNING *department routine which increases the speed of handling work in one concern and insures the customer of prompt delivery on every order.*

The planning department routes and schedules all orders through the factory. This department specifies upon a route and schedule card all the different operations which are to be performed upon the order, and specifies, as well, what machine and what special tools are to be used. The time limit for the operation and the premium time, if any, is stated. The planning department has charge of all demonstrations and all tool equipment throughout the factory. With the route and schedule card is also issued an identification card.

A foreman's order (Form II), sent to the sub-foreman of each department where an operation is to be performed upon the particular order in question, is also made out at the same time.

The sub-foreman's order gives the order number, the number of parts and the routing. The identification card is attached to the schedule card and is intended for the use of the inspectors, and, in fact, every one who has anything to do with the parts. After each operation

PARTS PRODUCTION ORDER NO.______

DATE______191______FOR CUR. STK.______PCS.______FOR REP. STK.______PCS.

NAME OF PART______

TO FOREMAN______DEPT.______

STOCK REQUISITION

MATERIAL______ REQUIRED______

MATERIAL______ DELIVERED______

SUB. REQ. NO.______ DELIVERED______
STOCKKEEPER

RECORD

DATE COMPLETED______PIECES TO STOCK______PIECES TO SCRAP______

FORM I: A production order like this is made out in quadruplicate by the stock room when finished parts run low

has been performed, the inspector enters on this card the name of the next department to which the work is routed, together with the number of parts which have passed inspection after the previous operation.

When the production department receives its copy of the production order, a tracer card (Form III) is filled out and filed numerically according to the part number. The information regarding the progress of the work through the factory, which is placed upon this tracer card, comes from three different sources. After copies one and four of the order have been delivered, together with the route and schedule card, and the material has been received, the sub-foreman is very careful to see that

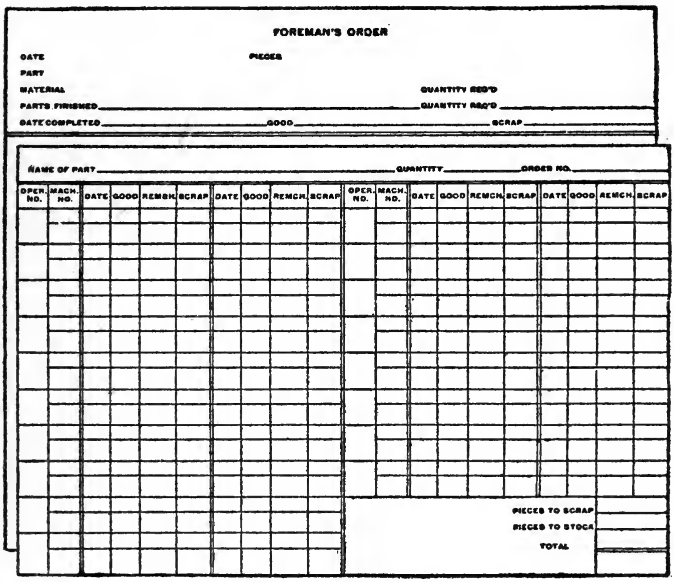
the parts are machined in the time and manner specified on the schedule and routing cards. When an operator receives the route and schedule card, he reports to the time-computing clock station in his department and presents the card to the boy in charge.

This boy makes out a record known as a job ticket which shows the part number, the order number, the man's clock number, and the operation to be performed, and immediately rings in the starting time of the man for that particular job. This card is kept on file at the clock station. When the man has completed the operation on the entire number of pieces called for, he again reports to the clock station and his time of finishing the operation is punched upon the clock card. The clock card for each particular job is retained at the clock station until the work has been examined by the inspector, and the number of good and spoiled parts is entered thereon. The card is next sent to the production department for entry on the tracer card mentioned before, after which entry the card is sent to the cost office for recording.

As soon as possible after each operation, the inspector examines the various parts and punches the route and schedule cards opposite the previous operation number, and also makes his entry on the attached identification card. He thus specifies the number of good parts, and in this manner gives the production department full information concerning the complete order. The production department is responsible for the upholding of the order schedule and makes a report of any delinquencies. From the tracer card this department can at any time determine the exact condition of any order.

This completes the handling of the production orders for stock. By means of the system there is available a

supply of parts for assembling cars to meet the requirements of the sales department. The second class of orders—the assembly orders—are based on orders from the sales department three weeks in advance of requirements. When the production department has this in-



FORM II (back card): Foreman's order, which explains operations in detail. FORM III (front card): The production department's tracer card, used in following orders through the plant

formation, it issues complete assembly specifications to the assembly department. In the assembly floor, it is given a sales order number by the production department. Requisitions are issued on the finished stock room for complete parts for this frame, and these parts are delivered from the stock room in a special truck designed to hold all the parts required for a single ma-

chine. The frames are numbered consecutively by the frame department and are delivered according to their number.

After the trucks have been finished on the assembly floor, they are passed to the final inspector, who, if the trucks are satisfactory, turns them over to the test department, and a very thorough test is then given them. If any defects materialize, corrections are made and the truck is tested until the inspector is satisfied that it is correct.

The finished stock department furnishes a shortage list to the planning and production departments three weeks in advance of requirements, and with this list as a guide, the planning department is enabled to properly schedule the work. No order is issued for which there is not sufficient material in the stock room to completely fill the order. Both the finished stock and the rough stock departments furnish a daily report of all parts that are received into the stock room.

This system enables us to fill orders promptly as they come in, and the speedy deliveries we are able to offer is a big factor in building business.

KNOWLEDGE *of the condition of the manufacturing department; its percentage of uncompleted work, the condition of this work and the factory's capacity for further orders, has a financial value. The cost of production has been shown to be lowered after shops have instituted a well-managed production department.*

—Hugo Diemer

Professor of Industrial Engineering, Pennsylvania State College

XX

STOCK ROOM METHODS THAT MEET PRODUCTION NEEDS

By W. Poole Dryer
Managing Director, The W. Poole Dryer Company

ALL THINGS being equal, the factory which is in a position to make the quickest deliveries or furnish promises that are the shortest and which are absolutely adhered to, will soon single itself out from other concerns. Our company realizes this fact. We have made a careful study of conditions necessary to obtain such results and with this in view, revised and changed our methods and organization so as to be able to furnish prompt service.

Controlling devices are usually of secondary importance in electrical installations and so the ordering of this material is often neglected until the last minute, usually until some time after the motors and other equipment of the plant have been contracted for, with the result that a large number of orders are placed by customers calling for automatic controllers to be delivered in unusually short periods.

In building up a system that would meet these emergencies, it was found that obtaining raw materials with which to manufacture these devices was one of the great stumbling blocks. Delays of this kind often injured progress considerably. Suppliers made promises they could not meet, and their deliveries were very slow. Some of them probably learned from experience that

most of their customers asked for unusually short deliveries when they did not actually need the material until later. Delay in getting these stores was further increased because the dealers in electrical supplies were located at a distance.

One of the natural solutions of this problem was to maintain a large reserve of stock material to draw from. This meant, however, tying up a large amount of capital, to say nothing of loss through possible obsolete stores. Consequently this solution was abandoned in favor of a rational and well-governed ordering and production system.

THOROUGH *order and organization in the stock room, with maximum and minimum limits to guide ordering, make prompt delivery to customers possible.*

The present results were obtained primarily through a revision of the methods used in the stock department in the issuing of material, in the ordering of material, and in the method of obtaining it from the supplier. In the revision of the stock system it was found that above all, a store room must be kept orderly and tidy and that material must be placed in bins, racks or on hooks, and that nothing whatever should be allowed to lie around on the floor where it would degenerate into the rubbish heap or consume the storekeeper's time in trying to find it. The bins were therefore grouped according to a general classification of material. All copper wire bins are now placed together, also all bins for iron castings, brass castings and patterns. In electrical apparatus small screws, nuts and washers differing greatly in length, shape, diameter and size are used. These are now kept in glass jars so as to be readily detected. Everything is so arranged that no time is lost in locating material, for

it is realized that the wages of a workman continue while he is waiting at the store window for his stock. In order to locate all material with the least amount of time, every box, bin, rack and hook is given a permanent

ITEM NO.______ MIN. STOCK ______ RE-ORDER QUANTITY ______ BIN NO. ______

MATERIAL	FIRM NO.	PURCHASED FROM:	AT RATE OF
	1		
	2		
	3		

FIRM NO.	MATERIAL ORDER NO.	DATE		DAYS DELIVERY	FOR S. O. NO.	QUANTITY		STOCK	
		ORDERED	RECEIVED			RECEIVED	ISSUED		

FORM I: The bin record of stock, forwarded to the order clerk when the minimum is reached. Once a week bin cards selected at random are checked against amounts on hand to insure accuracy

bin number which is painted on it, the numbers being arranged in order, so that the bin may be instantly located.

The key to bin numbers is placed on bin cards similar to those shown in Form I. This form is so made out that it helps materially in expediting the work; an exact record of the available stock is essential and this form meets the demand very satisfactorily; if the cards are carefully scrutinized periodically, the material should never fall below the danger level. There is one card for every item of stock. Each size screw, for instance, has a bin number, and so has each size of rod and wire. At the top of the bin card is given a description of the material, and below this a record for the re-ordering, receiving and issuing of new material. When the order clerk in the general office orders additional material he

fills in at the top of the bin card the name of the supplying company and the rate at which the material is being purchased. In the column below he fills in the number of the supplying company, the number of his outgoing material ordered and the date of ordering. This card is then sent back to the store room. When goods are received, the stockkeeper fills in the date and the quantity.

Delays previously suffered because of slow deliveries have been largely eliminated by the use of date columns on the bin cards showing the number of days actually taken by each supply house to furnish the material ordered. This record of delivery is a guide to the order clerk in selecting the right firm to order from.

In order further to expedite the work in the store rooms, the man in charge of the stock, in issuing material to workmen, fills in the number of the shop order on the requisition and also the quantity issued, at the same time deducting the quantity from the stock column on the bin card. All outgoing material is charged on the bin card against the shop order, so it is impossible for any material to go astray.

It is important that the maximum and minimum limits be determined with care. The minimum quantity is determined by the period required to secure a fresh supply of material and it should be sufficient to cover the needs of the factory in the meantime; in other words, it should include the time necessary to convert this material into finished product. In order to preclude any laxness in methods used in this department, the order clerk periodically goes over all bin cards and the maximum and minimum quantities are revised, the first being increased when an inspection of the card shows the occurrence of shortages before new deliveries arrive and

when it is obvious that quantities specified necessitate a too frequent re-ordering. As it is not known at just what time the order clerk will make this investigation, there is a tendency at all times to keep the system working efficiently.

As a great deal depends upon the care with which the bin records are kept, an effective check must be made regularly to test the accuracy of these records. In addition to the periodical testing of the methods used, the order clerk has a standing instruction to check over every week ten bins selected at random and to lay before the manager a report giving a comparison between the stock recorded on the bin cards and the stock actually found in the bins. By doing this regularly the store room is kept in order. The trouble involved in securing rigid accuracy in the store room has been amply repaid by the elimination of delays due to shortage of material.

ANTICIPATION *of future orders prevents the possibility of materials being out of stock when needed—how to handle requisitions and raw material orders.*

It has been found worth while to have in charge of the stock a man with systematic habits; to attempt to run a store room with cheap help is false economy. In addition to devising an efficient store system, it is highly important to eliminate the personal element from all routine. The arrangement of materials and bins must be such that a change of head storekeeper or any of his assistants will not throw the system into confusion. This danger is guarded against by sectional listing of the store according to kinds of material and by the key on the bin cards, so that it is possible for an article to be immediately located by any one having practically no

knowledge of the stockkeeping system.

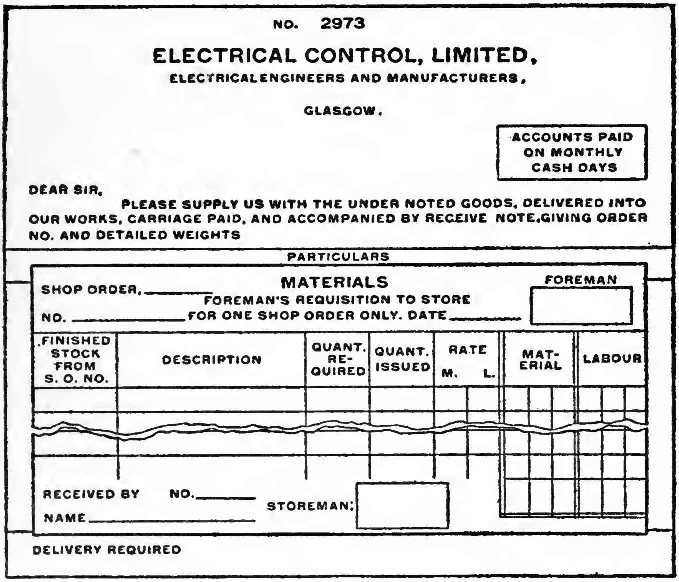
Our investigations showed that serious delays to work would occur when the order department had not anticipated shop requirements or when special material was required.

To prevent such a delay, the storekeeper is now instructed to check orders as soon as he receives them, with stock on hand. In this manner low stocks may be ordered instantly and supplies received by the time the shop is ready to use them. The material to be ordered is ascertained by the storekeeper by allotting on his bin cards each item required for shop orders. The material is not actually taken from the bin until the workman applies for it; it is merely allotted so that stock shown on the bin card indicates, not the actual quantity in the bin, but free stock available.

By anticipating withdrawals of material in this way, the minimum quantity is struck a week or two earlier and the bins replenished that much sooner. This, of course, adds to the rapidity with which this department can handle all stock orders. It also has another advantage: it is not necessary to carry large stocks at all times, but merely to look ahead and eliminate delays which previously occurred frequently. This one feature, anticipation in re-ordering, has resulted, not only in cutting down standard deliveries by many days, but has also cheapened production.

It is impossible for the drawing room to anticipate every bit of material that the company requires on all shop orders. Invariably certain materials are neglected until the last minute, usually when the assembly of parts has commenced. It would then be too late to order additional material sheets through the regular routine and it becomes necessary to devise some quick

method of obtaining this material. The gang boss trusted with the job obtains the bulk of the material on presenting the shop copy of the order to the storekeeper; thereafter he is responsible for this material. As the special features of design are worked out, material is brought to light, the chief draftsman sends to the foreman instructions regarding what extra material is required.



NO. 2973

ELECTRICAL CONTROL, LIMITED,

ELECTRICAL ENGINEERS AND MANUFACTURERS,

GLASGOW.

ACCOUNTS PAID ON MONTHLY CASH DAYS

DEAR SIR,

PLEASE SUPPLY US WITH THE UNDER NOTED GOODS, DELIVERED INTO OUR WORKS, CARRIAGE PAID, AND ACCOMPANIED BY RECEIVE NOTE, GIVING ORDER NO. AND DETAILED WEIGHTS

PARTICULARS

SHOP ORDER, ____ MATERIALS FOREMAN

FOREMAN'S REQUISITION TO STORE

NO. ____ FOR ONE SHOP ORDER ONLY. DATE ____

FINISHED STOCK FROM S. O. NO.	DESCRIPTION	QUANT. RE-QUIRED	QUANT. ISSUED	RATE M.	RATE L.	MAT-ERIAL	LABOUR

RECEIVED BY NO. ____ STOREMAN:

NAME ____

DELIVERY REQUIRED

FORM II (back card): Order form sent to the supplier when goods are requisitioned. FORM III (front card): The foreman's requisition on the stock room for materials

As the job proceeds and these parts are needed, the foreman writes out a material requisition card (Form III) and gives it to the workman, who obtains this material on presenting his requisition to the storekeeper.

All requisitions are collected from the store rooms daily by the cost clerk.

In order that the cost of jobs may be determined accurately, it is essential to prohibit the drawing of stores on informal requisitions, as these are afterwards lost or easily overlooked. The storekeepers are instructed to recognize no requisitions for material except the shop orders or material requisitions duly initialed by the foreman and with the necessary information carefully filled in.

After every possible chance of expediting the work in the factory was put into effect, the investigation was turned to the outside, and a systematic study was made of the suppliers of raw material. If they could be made to cut down their delivery period twenty to thirty per cent, it meant an equal saving to this company. It was also found necessary to revise, to a certain extent, the methods of ordering this material; the method of handling now is as follows:

All orders for manufacturing material are sent out on an order card (Form II) by the order clerk. He receives all information regarding what is required from the bin cards sent from the store room, for when the storekeeper, on allotting material for the job on his bin cards, reaches the minimum stock limit, he immediately sends these cards into the office for re-ordering. The order clerk sends out to the supply house his order for the material. He also records on the bin cards the material order number and the date of each card for which material is wanted.

The additional material not anticipated in advance is ordered when the clerk receives instructions from the drawing office direct. The outgoing orders (Form II) are made out in duplicate; the carbon copy sheet is retained

by the order clerk and filed away serially in a live order binder until the material is invoiced, when it is transferred to a supplier's binder for future reference.

The routine followed in this shop makes it easy to secure materials in the shortest possible time, giving the management assurance that the wheels will be constantly turning, and letting the salesmen feel that their "hurry" orders will not be lost sight of.

A PROPERLY *established stock room should more than pay for itself within a year. Not only is the stock room an insurance against loss or theft, but by means of the material records kept therein, orders for raw material can be placed to the best advantage, and quantities for purchases accurately gauged.*

—Kenneth E. Clarke

XXI

FOLLOWING THE WORK BY PLAN BOARD

F. M. Feiker

ONE manufacturer who had been reading how the principles of scientific management may be applied in his factory got, first, a new viewpoint on his factory work; second, a group of suggestions on mechanical methods of handling orders and clerical work, such as the economic system of numbering tools and of marking bins, the ten-hour clock dial and the plan board.

Without going deeper into scientific reorganization, a manager may easily apply any or all of these little methods of handling the routine of a factory and get good results. Among these instances of ingenuity applied by men who are adopting or adapting the methods of scientific management, the plan board is one of the most interesting and one of the most generally helpful.

Essentially, the plan board is a graphic card index—a well planned follow-up system. Many factories have applied the graphic follow-up system in other forms, but the plan board, if put into effect in an organization, helps to educate the organization in the principles of more scientific methods of handling work.

A plan board requires at least three things for its successful operation: first, a planning department or a planner—a central source of all orders; second, a method of shop organization by departments to enable work to

be handled clerically with as little time and effort as possible; and third, a careful order system. The second usually involves subdividing the factory into as many processing departments as may be necessary, and giving each of these departments a key or letter number by which it can be called in the records. If carried out in its entirety, the plan board also makes necessary a complete system of numbering stock parts, patterns, tools and general equipment. The plan board makes essential a skeleton system of ordering work—some sort of card plan by which each order that comes in is given a number by which it is known thereafter.

The plan board, consequently, really makes necessary the introduction of a system of handling the work in a factory, no matter what that work is. This is one of its chief values. Another practical value of the board lies in the fact that it shows graphically the progress of the work; it holds up before department heads at all times the progress of work and fixes responsibility for delays. Spread out on the wall as it is, the effect of this follow-up is psychological. It tends to keep-up department output and to fit the work of one department into that of the next.

These are the chief reasons why the manager of the production department in one concern decided to adopt the plan-board principle in the handling of its work. The methods this production department used for applying the plan board show how the board may be applied to other classes of work. For it is the idea of the plan board which is valuable—not the card system involved or the mechanical method of construction employed in this particular case. Probably, the particular card system employed by this production department could not be used in any factory without modifications, but the fact

that the plan-board idea which has been adapted by this production department was a combination of ideas taken from the plan boards used in other factories shows how the essential elements in it may be adapted to all sorts of conditions.

The board cost seventy-five dollars and was built on contract by a local carpenter. It is built up from birch lumber. Rough boards about twelve feet long were ripped into strips ranging from two to three inches in width. These strips were laid side by side, glued and clamped until dry.

PLAN BOARD *made for the production department of one concern—how it can be used to follow the order through the factory and keep track of processing.*

This board complete measures about eight by twelve feet and had to be built in three sections so that it could be carried up the elevator and assembled on the wall where it is used. The matter of building the board in sections may seem obvious, yet this particular board, which is located on the sixteenth story of a building, had to be constructed twice, because the carpenter in taking it up the elevator shaft the first time dropped it after it reached the fourth story.

The board was stained, polished and striped in place. The completed board is divided into four sections: the first section labeled "Ideas," the second "Plans," the third "Tasks," and the fourth "Supervision." Of course, this subdivision of the board is one of the features which would differ when the idea is adapted to other lines of work. In the average production department, the section labeled "Ideas" would be reserved for "Orders Ahead," although the other three might stand as given.

Hooks are used for holding the cards, a pair of hooks for each card. These hooks are spaced two and one-half inches and holes in the cards are punched to correspond. For convenience, each double row of hooks is made a unit by drawing a vertical line midway between each pair. This makes it easy to distinguish the pairs of hooks along each vertical row.

As it was essential that the board always present a uniform surface, one other detail of construction is

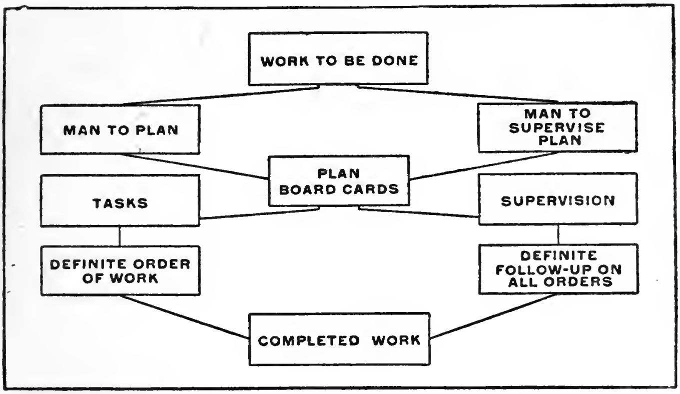


FIGURE XIV: This analysis of the plan board shows how it operates, and indicates the natural sequence in the process of getting work done

worth mentioning. The three sections of the board are connected by reinforcing strips. These strips are fastened to the board by screws placed in slots so that the various sections can expand or contract without splitting or warping the front face of the board. The board is mahoganized; the lines of subdivision for groups are drawn with aluminum paint, while the vertical unit lines for the hooks are drawn with green paint.

It is obvious that the cards hung on this board may be placed in a great variety of combinations and that the

method of handling the cards depends entirely upon the kind of business.

The section labeled "Ideas" corresponds to work ahead in the factory. Later on, these ideas develop into plans, and from plans they become tasks. The card system for handling a plan is interesting. Card forms are printed in perforated strips of nine cards each. When a job is planned it is laid out into tasks by the planning department. The planning department in this case is not an elaborate organization but the head of the production department and his chief assistant. The way this little organization works when handling an order is shown in Figure XIV.

The first card of the nine is reserved as a general outline of the work. Each of the other cards represents one detail of the work to be performed by one member of the production department or by some department in the organization. Under other conditions, each card might represent a job to be given to a workman, or an order that was to go on some special machine, or an order to be handled by some one department.

When an idea in this particular production department gets to the stage where a plan is made for it, a plan card is filled out and is hung on the hooks corresponding to plans. There it is ready to be pushed on through the different operating departments as the work each day progresses. As soon as the date on which the plan is to be put into effect is decided upon the strips are properly filled out for the work to be done by each department and are hung in the subdivision Tasks. The first card at the top of the strip, on which is written an analysis of all the other cards, is hung on a pair of hooks in the subdivision labeled "Supervision." Each morning the cards are distributed according to this plan

so that tasks may be assigned to suitable departments. Each row of hooks in the subdivision, "Tasks," is headed by a label holder and in this label holder may be placed the name of the department where the tasks are assigned. The names in the label holders may be changed according to the number of jobs in the department, which makes the board very flexible.

When a certain job is to be hurried, a glance at the task slips, still hanging on the board, reveals at once who is holding back the work. The cards that remain in position there are graphic layouts of the work still to be done. If one man is taking more time than was scheduled to complete his job he must be followed up and the little card record of the task he was assigned becomes, therefore, a follow-up slip.

What this method of handling orders saves in one production department it may save in production departments doing other classes of work. The mere introduction of this plan of handling work throughout the department has definitely fixed responsibility for orders. It has saved delays in handling the details of ordering; it enables the department head to know each morning the standing of orders and to follow up all the details connected with them.

It does away with the crowding of departments. When work is assigned to a department scheduled by dates it is evident, by a glance at the board, when other work can be assigned to it. By keeping track of the dates on the cards, it is possible to estimate the amount of time an order will take. It is also possible to tell, by comparing dates and times, how long it takes to put a certain quantity of work through a department. This one fact alone may lead to the standardization of methods in a department so that it will always take the same

time to put through the orders, and so that causes for delays will be known and there will be greater possibilities for removing the causes, because they have been so tabulated. In short, it enables the planning executive of a factory to hold the reins and definitely control production.

FACTORY *plants can no longer be run in the haphazard manner of former years. A system of schedules, by which the manager plans his processes and his output months ahead of time, is an absolute necessity in order to face the attacks of competition and eliminate all elements of uncertainty and waste in production.*

—Robert Daily

Of The Mitchell-Lewis Motor Company

XXII

MAKING DELIVERY DATES GOVERN PRODUCTION

By W. Poole Dryer
Managing Director, The W. Poole Dryer Company

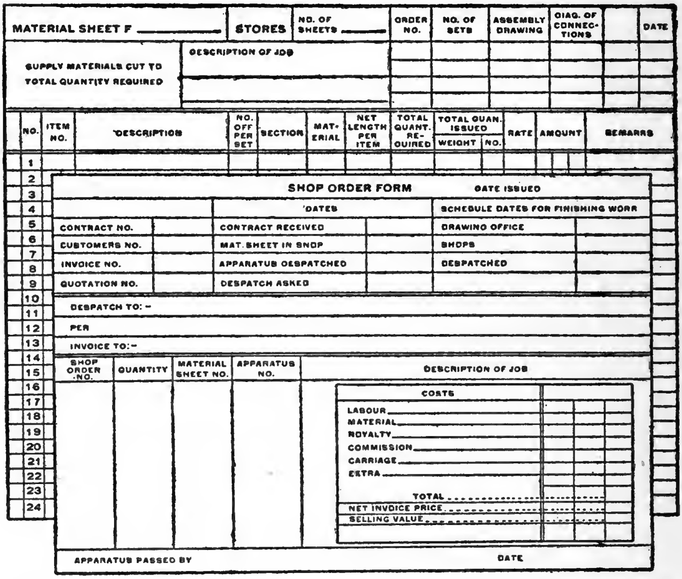
QUICK delivery is one of the most effective means for establishing new connections. In our factory, apparatus was complicated and could not be stocked quite finished; so careful organization of production seemed the only solution of the quick delivery problem. Before organization came analysis; for it is only by previously investigating in detail the hindrances and delays that an appropriate system of routine can be established.

Our chief product is automatic starters for electric motors. The duties performed by such apparatus are so various and the voltages of circuits differ so much in various places that stocking finished goods is impossible; the most that can be done is to stock partly assembled apparatus—only those parts common to all requirements. In some lines even this cannot be done, for standardization is next to impossible. As far as possible, the component parts of the apparatus are made up in large quantities on stock orders; from them any combination can be readily made up to suit customers' requirements.

Finished stock parts are in the same category as raw materials; corresponding to bin cards used for the latter are the "Stock Record Cards" (Form VI) of the former.

There is one such card for each stock part or group of parts; on this is entered the number of the "Stock

Shop Order" and the quantity made is also given. As contracts require, these stock parts are allotted to the "Contract Shop Orders," the quantity allotted and the number of this new shop order being stated on the stock record card. The difference between the "Ordered" and the "Allotted" quantities gives the "Free Stock or Order," which is analogous to the raw material in bin



FORM I (middle card): Shop order form, made out in multiple. FORM II (small card): Reverse of FORM I, showing cost details. FORM III (back card): Material sheet, giving instructions as to material needed

in the case of raw stores; one difference, there is, however, the "Free Stock on Order" may still be in course of manufacture.

When the requirements of contract orders have reduced the free stock to the minimum noted at top of

card, a replenished "Stock Shop Order" is issued to the shops. These manufacturing instructions are issued on the "Shop Order Form" (Form I) and are treated after the same fashion as "Contract Shop Orders," as will be explained. After the receipt and acceptance of a contract, the order is recorded in the Contract Book (Form IV), where the contract is allotted a serial number. No information is given in this book as to the nature of the job; it merely states the customer's name and the "Shop Order" number—this being filled in after the manufacturing instructions are made out. The name of the salesman also is noted in the contract book, which is used in computing commissions. The customer's order is then passed on to the engineer so that the machinery of production may be set in motion. Since incoming orders contain much technical description, the actual order form sent by the customer is passed on by the general office to the engineer, who, without delay, translates the technicalities into the standard nomenclature applied by the company to its apparatus. The engineer drafts out the "Shop Order," giving general manufacturing instructions; then returns the customer's order to the general office, where it is filed in the "Live Binder of Customers' Orders," with the number of the contract and the "Shop Orders" noted on it.

ROUTINE *of handling the order so that production may start promptly—how each department is notified in advance so as to be ready for coming work.*

The full draft of the "Shop Order" is entered into the "Shop Order Book" (Form V), which constitutes the permanent record of manufacturing orders. This book allots shop order numbers to the various apparatus in the contract. Here is also specified the general type

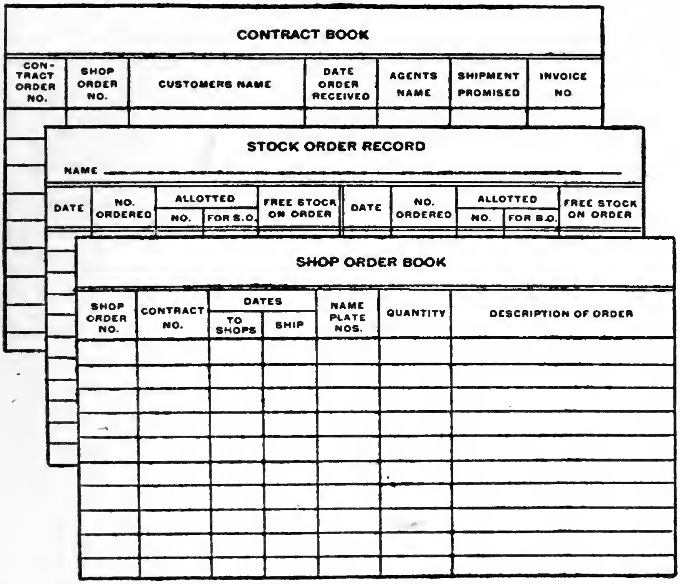
of the constituent apparatus required; the number of complete sets, and whether the component groups are to be taken from stock or made to new material sheets; the description also gives particulars of the final electrical tests to which the apparatus must be subjected.

All the information in the "Shop Order Book" is copied on the "Shop Order Form" (Form I), five typewritten copies being made. This "Shop Order Form" was devised to be as comprehensive as possible; it is the fundamental sheet of all production, fulfilling functions ordinarily necessitating a great number of different forms.

This basic sheet carries to all departments the general instructions and the key to detail instructions required by them right up until the time the goods are dispatched; and ultimately this copy has recorded on it the cost of the job, and the subsequent history of the apparatus. The "Shop Order Cards" perform all these diverse functions by making all five copies of it carry the same general description of the apparatus; then before distributing the copies to the various departments, the particular instructions applying to each section are added on the respective sheets.

Reference to Form I will show how, by using one sheet in duplicate in this way, a large variety of instructions can be distributed throughout the organization at one time. With merely the manufacturing instructions thereon, all the copies are passed by the engineers to the manager's office, where the instructions are first checked. One copy to be retained in the manager's department, is filled out in full detail; up in the right-hand top column is placed the complete time schedule of the job. This is fixed from a consideration of the customer's requests, the capacity of each department and the state of stock.

The middle top column is used for "history" dates. Transportation instructions are also filled in, together with the name of the customer to whom the invoice must be sent—these names are usually the same, for the goods are usually sent to the customer direct; hence this key



FORM IV (top card): Contract book which lists orders. FORM V (middle card): Stock order record, in which one card represents each stock part. FORM VI (bottom card): Shop order book containing permanent shop order records

copy of the "Shop Order Form" retained in the manager's department tells everything about the job. It can, therefore, be used for following production day by day without the need of referring to any other record; moreover, it is the one copy put on permanent file; its obverse side records the costs and the ultimate history of the goods. The other four sheets of the "Shop

Order Form'' have on them the particular information each department requires. These copies are then distributed to the chief draftsman, the shop superintendent, the testing department and the dispatch clerk.

The four copies to the different productive departments constitute merely the general authority to the shops to engage on the shop order, charging time and material to it. Work cannot be commenced by them, however, until full specification lists of the material to be used on the job are issued from the drawing office. The burden of forwarding the work is therefore on this department, which issues full instructions and drawings. The instructions are all embodied on the ''Material Sheet'' (Form III) and specifies all material required. Each material sheet has a distinguishing number prefixed by the letter ''F,'' and from the master tracing sheets retained in the drawing office blueprints are issued the shop, stores and cost departments.

PROGRESS *of work is watched and regulated by the production room, which has the general direction of orders and keeps all departments busy.*

Referring to Form I, it will be seen that the third lower column on the ''Shop Order Form'' denotes the number of the material sheets to be used for the job, while on the material sheets are given the number of the drawings to be used and also particulars about the material. As will be seen from Form IV, the material sheets constitute a full specification of the details of the job; the right-hand columns are blanked out white on the blueprints so as to allow the store man to fill in the columns recording the material issued; this also allows the cost clerk to make up the material costs.

The foregoing description outlines how the starting

of work on a shop order is authorized by the issuance of "Shop Order Forms" to each department. Further particulars are carried on the "Material Sheets" and drawings. It is essential, however, that the progress of all the jobs be followed day by day from one central point or department, and this is the duty of the production clerk in the manager's department. Here all the productive sections are coordinated and from this focal point all departments are watched to insure that they are keeping to schedule—that each is regularly feeding the next department with necessary instructions and materials. Particularly is it the function of this production department to release deadlocks and congestion in the progress of the jobs. For instance, when raw material is being delayed in railway transit, the production clerk gets after the railway company and has it followed by telegraph tracers who immediately get on the tracks of the delayed consignments; or the shops may have overlooked the manufacture of some one part—a minor part, it seems, yet quite as potent in retarding the dispatch of the largest casting on the apparatus. Here again the production department steps in and sees that the foreman gives special attention to the backward work. In short, the production department has complete control of the time element of all work. It is given plenary powers to initiate exceptional procedure to meet exceptional hindrances. Coordinating all producing sections, the production department is subservient to none.

When the workshop has completed its manufacture, the apparatus is wheeled to the testing department, where it is subjected to rigorous mechanical and electrical tests. Every magnet coil has applied to it the same current and voltage that the customer will use.

In fact, it is operated under conditions as nearly as possible identical with those to which it will be subjected in actual use. It is operated, not once or twice, but many times, so that latent weakness may be revealed and corrected before dispatching. All the apparatus is automatic; on this account the endurance tests to which it is subjected are unusually severe, for any failure to perform its unobserved functions might result in grave disaster to an extensive plant. On the testing department copy of the "Shop Order Form" the particular operating and testing conditions of the apparatus are given. When the tester is satisfied that the goods are mechanically and electrically reliable, he has them inspected by one of the special engineers, who has final authority to "pass" the apparatus. Not until the initials of one of these engineers are put in the space at the bottom of the tester's "Shop Order Form," left for that purpose, can any goods leave the testing department for packing.

The tester hands his "Shop Order Form" to the dispatch clerk, who gives packing instructions to the shops. He sees that no goods are packed except those for which he has received initialed sheets from the tester.

After the goods are dispatched the job costs are entered on the back of the "Shop Order Form" used in the manager's department. This information consists of:

(1) The various directly assessable costs incurred by the company in producing the job.

(2) The "Invoiced Price" of the job—that is, what the customer is charged.

(3) The "Selling Value"—what the customer should have been charged.

With the cost information filled in, the "Shop Order

Form'' is then filed away in serial order in the ''Complete Contract Shop Orders'' binder. At any future time the customer, on requiring any part replaced or changed, need only telegraph his desires along with the ''Apparatus Number.'' Since these numbers run parallel with the shop order numbers, reference to the ''Completed Customer Orders'' binder immediately gives the key to all the particulars of the apparatus. The change effected is recorded on the lower half of the obverse side of the filed copy of the ''Shop Order Form''; thereby the history of the apparatus is kept up to date on the same sheet which contains the original description of the work.

TO MAKE *immediate delivery from stock, to get out orders in the least possible time with a minimum stock, to manufacture and complete customers' orders in a minimum amount of time, to handle rush jobs efficiently, and yet maintain a constant supply of material passing through the plant in a continuous steady stream in no greater quantity than is absolutely necessary, to insure a steady supply for all workers—these constitute the duties of the routing and production department of the factory.*

—H. C. Wright

XXIII

SHAPING TOOL ROOM SERVICE TO THE WORKMAN

By J. T. Carpenter

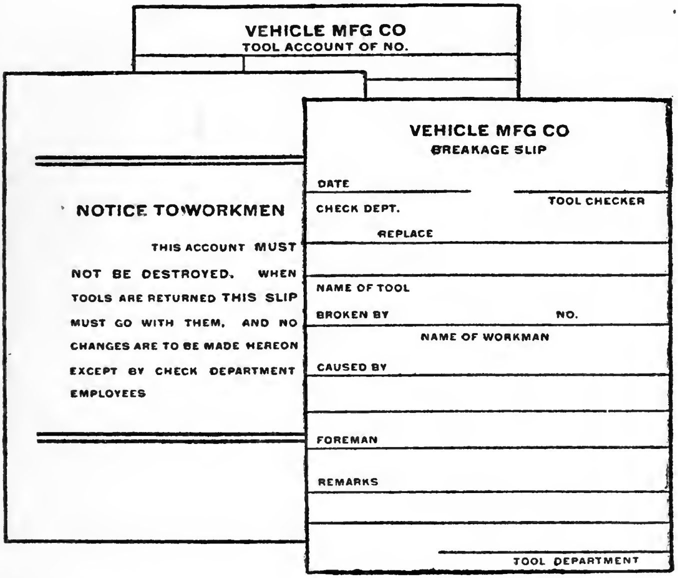
HIS grocery store furnished the manager of a large middle western factory with an idea for checking tools in and out of the tool room. In his shop, as in many others, the workmen were supplied with numbered brass checks. One of these was left with the tool room keeper for each tool drawn out and was returned when the tool was brought back.

If several men apply for or return tools at once under this usual system, time is lost by the attendant in getting the tools and handling each man's check in the empty tool space, or vice versa, and both confusion and disputes are apt to arise. When he comes to return a tool, the workman will often leave it without waiting for his check, if others are before him, trusting to get the check later. This is inevitably a prolific source of disputes, particularly if a tool is broken.

A system which replaces this arrangement is the method many grocery and other small retail stores use to keep a record of their customers' monthly accounts. When a workman applies for a tool a record of the fact is made on the account slip (Form I). The slips are made in duplicate, the original being retained by the tool room keeper and the copy handed to the man, together with the tool. Each slip, with its duplicate, bears

a consecutive number for identification purposes. The original slip is filed in an account register, each workman being given a space in the register bearing his number.

When the tool is returned, it is merely handed in with the duplicate slip. The workman's responsibility ends



VEHICLE MFG CO
TOOL ACCOUNT OF NO.

NOTICE TO WORKMEN

THIS ACCOUNT MUST NOT BE DESTROYED. WHEN TOOLS ARE RETURNED THIS SLIP MUST GO WITH THEM, AND NO CHANGES ARE TO BE MADE HEREON EXCEPT BY CHECK DEPARTMENT EMPLOYEES

VEHICLE MFG CO
BREAKAGE SLIP

DATE
TOOL CHECKER
CHECK DEPT.
REPLACE
NAME OF TOOL
BROKEN BY NO.
NAME OF WORKMAN
CAUSED BY
FOREMAN
REMARKS
TOOL DEPARTMENT

FORM I (back card): Tool accounts made out in duplicate. FORM II (left card): Notice issued on back of FORM I. FORM III (right card): "Breakage slip," which places responsibility for damaged tools

there, unless the tool is broken. In that event he hands in a "breakage slip" (Form III), which must be signed by the foreman, in addition to the duplicate slip. It is thus possible for the tool room keeper to receive a number of tools at once, without delaying any one, and he can replace the tools and sort out the slips when the

rush is over. When a tool has been returned, the original slip referring to it is removed from the register and refiled with the duplicate for future reference.

A tube at the left of the account register connects with the foreman's cage across the aisle. When a man reports one job as finished the foreman drops a slip with the workman's number and the number of the job he will go on next into this tube and a light air pressure takes it to the tool keeper's desk. He then starts assembling the tools needed for the next job at once and there is no delay when the workman applies for the tools.

When the handling of the more expensive equipment is involved, such as very costly jigs, milling fixtures and other special tools used in the manufacturing departments, the old brass check system is apt to be unsatisfactory. A system is here required which places the responsibility definitely on one person without chance for dispute between the storekeeper and employee.

A large eastern automobile company had to contend with this situation and at the same time realized that in adopting a new system care should be taken to avoid an undue amount of clerical work or otherwise this might offset the advantages to be gained. They finally adopted a scheme somewhat similar to the one just described, except that the form which is used in place of the check is made out in triplicate. The entries of the number of the employee taking the tool from the store room, the number of the part for which the tool is used and the inventory number of the tool, together with the description of the tool and the use to which it is to be put, is filled in by the storekeeper and the employee taking out the tool signs his name in the space provided against the date borrowed. Below this there is a similar space for the date of return and signature of the tool storekeeper.

Each of the carbon copies is on a different colored paper. The original and second copy are retained by the storekeeper, while the third copy is handed to the person signing. The first copy is filed by the storekeeper under the employee's clock number, so it is always possible to ascertain just what tools he has out, and the second copy is filed under the tool number, so that present location of any certain fixture or tool may be readily ascertained.

In returning the tool, the employee takes his copy of the card to the storekeeper who signs for the tool in the space provided. The two cards in the storekeeper's file are then transferred to the dead file. At the time of signing the receipt for the return of the tool, the storekeeper also notes any damage done while in the employee's possession.

As the storekeeper has signed receipts for all tools taken out, and the employee has similar receipts for all returned to the store room, any dispute can be very quickly and surely settled, as the responsibility is squarely placed.

STANDARDIZATION *of methods, equipment and production is the ultimate end and aim of practically every American factory management.*

—R. E. Carpenter

Of The Taft-Peirce Manufacturing Company

XXIV

MAKING QUALITY AUTOMATIC

By Daniel V. Casey

ASSUMING efficiency of equipment, skill of operatives, correct design and workmanship in tools and product as manufacturing essentials, a factory system of tests and inspection recognizes its responsibilities for four elements in every making problem:

1. Raw materials: Quality, quantity, suitability to product.
2. Processes: Standardization, economy, insurance against failure.
3. Product in the making: Uniformity at various steps secured by inspection and by physical and chemical tests. These also furnish a check on processes.
4. Materials consumed in manufacturing: Coal, water, tools, tool steel, oils, and so on.

Alone, an inspection system is a clumsy and costly method of securing uniformity of product. The trained eye and sensitive fingers of an expert can detect and throw out any article or part which falls short of the accepted idea of quality. With proper gauges he can guarantee fidelity to patterns. Manipulation of complicated mechanism will inform him whether it has the requisite ease of operation and proper adjustment of parts. A defective article or machine he sends back for

correction—unless faulty material is involved, when it is discarded. Except for mechanical errors—poor designs or careless execution—he can suggest no remedy, however—no method by which loss of the materials, labor, power and overhead outlay locked up in the rejected product, can be avoided next time.

LABORATORY *methods which are brought into play in the factory at every stage of production to make sure that the final product will be up to specifications.*

Here science enters—to supplement the cunning of trained eye and expert hand with the mathematically exact test of the chemical and physical laboratory. Raw materials, processes, product in various stages, all the attendant elements which influence output, are put under the microscope and held rigidly to the standard which experience plus experiment dictates. Where inspection stops, casting aside the defective product, the laboratory takes up the work, probes for the cause of failure, finds it, prescribes the remedy. Not only the failures—the happy accident which results in some exceptional product is also analyzed, its secret discovered, and so a new standard of quality set.

Science pays her own way. Before we established a factory laboratory and introduced laboratory methods in certain of our manufacturing departments, the records show that between the raw stock and finishing rooms, one-tenth of the product was thrown out by inspectors—usually in an advanced stage of manufacture. This was in a plant now fifty years old, owning the best steel formulas English and American genius had evolved and employing saw-makers whose fathers and grandfathers had followed the craft. The best human skill and rule of thumb could do was nine good saws in every

ten. Since the laboratory was given jurisdiction over raw materials and processes, ninety-nine saws in every hundred pass an inspection more rigid than before.

Our system of tests and inspection is typical of the aid which scientific methods can bring to a highly specialized industry. The scrutiny begins when a car of steel blanks or sheets is trundled up to the stock room door. A dozen different kinds of steel may be represented in the load—the company employs forty different formulas, each adapted to the work the finished saw will do — and the various kinds are weighed and gauged separately as they are unloaded, in order to check the weights furnished by the mills. Of each kind a sample is cut off for the laboratory and put into an envelope on which is written the name of the mill, the number of the formula, the size and gauge of the sheet or blank and the date of the shipment. Though unloaded, the steel is not put into stock until tested.

All saws are made of crucible steel, which costs three or four times as much as open hearth steel and can not be told from its poor relation by the unaided eye. There are good and bad crucible steels. The first test, immersion in acid, betrays both kind and quality. If, after several immersions, the acid has made but few pittings, highest grade steel is indicated. If many scattered pittings and grooves show under the microscope, it is crucible of second or third grade, for each melting modifies the quality of steel, and these pittings show that scrap was used in its making. If the pittings are comparatively deep and arranged in regular grooves it is evidence that the sample is simply a good quality of the open hearth product. For the open hearth or any but the first grade of crucible steel, the factory has no use, and the mill involved is notified to remove it.

If the sample proves an acceptable quality of crucible steel, half an ounce is milled off and subjected to chemical tests for the various elements demanded by the formula. Formerly carbon was the only element considered important, but experience showed that even with the right proportion of carbon, sometimes steel would not take the right temper. A series of tests of samples taken both from perfectly hardened and from deficient saws established the fact that the best of a certain kind were uniform in chemical constituents, while the discards showed some element of the best either lacking or in excess. The formula of the best saws was adopted, therefore, as the standard, and the mills were required to furnish blanks or sheets conforming to that quality. In like manner the formula for each kind of saw made was revised after a conclusive series of experiments, and failure in the tampering room was reduced from one in a hundred to one in a thousand blanks. Moreover, the entire product was brought up to the standard of the saws before regarded as exceptional.

Revision of these standard formulas has taken place on an average every six months. Whenever current discoveries in the properties of medium-priced alloy steel suggested a new element which might increase the efficiency of any saw, tests were made and, if successful, the formula was changed. Salesmen in the field were instructed to look out for old saws which had given remarkable service and to send samples of them for analysis. Unusual steel combinations were sometimes found in these veteran tools; and the knowledge went towards the improvement of the company's various brands. When you furnish saws to slice up timbers as diverse in character as oak, cork, pine, redwood, mahogany and teak—when one mill handles frozen logs,

another seasoned timber, a third, trees full of sap and water-soaked—when one saw rotates twelve hundred times a minute, the next travels a mile in twenty seconds over pulleys, like a monstrous belt, and a third spoils holidays for a farmer's son—when bone, steel, brass and plaster as well as wood must be chewed up at top speed—when you must meet these widely varying demands, the discoveries in alloy steel will hardly keep pace with the wants of your customers.

INSPECTION *must be thorough if customers are to be retained by giving satisfaction and also if you are to get right goods from your own suppliers.*

Absolute uniformity of constituents is not commercially possible even in the crucible steel within certain limits, therefore variations from formula must be permitted if the cost of materials is not to become prohibitive. To effect these irregularities, modifications in processes have been worked out to correct excess or deficiency of certain elements. If analysis of samples shows a consignment too high in carbon, for instance, the lot is put into a separate bin and labeled. Requisitions filled from this bin are sent through the factory as special orders, with a tag noting the variation for the foreman of the hardening and tempering room. With the tag for guide, the foreman manipulates his processes so as to draw more of the temper from these saws after hardening and thus restores them to the normal standard of hardness. For steel lacking in carbon, the reverse of this process is employed—repeated experiments having established the exact results which various temperatures will produce in the saws.

This argues the most delicate regulation of the hardening and tempering processes, and suggests the second

objective of a system of tests and inspection—standardization of processes with its accompanying economies in labor, power, materials and its insurance against failures on important or rush jobs.

During processing, every saw is inspected before it is passed along to the smithing anvils. If it be a hand tool, the inspector bends and twists it to make sure of temper and hammers it to prove its hardness. If it be a circular, band or cross-cut, he has other tests with set gauges as informatives. When a saw lacks snap or flexibility, it is condemned and sent to the laboratory for a post-mortem which will determine its ailment and eliminate the cause. Of the saws passed by the inspector as perfect, a certain proportion of each lot is subjected to further tests—physical, microscopical and chemical—in the laboratory, to guard against defects which might be overlooked by the inspectors. And, as a final measure of protection, the fuel-gas supplied to the furnaces is tested at least once a week—or oftener if the bosses report any falling off in quality or fuel value.

This is inspection directed toward perfection of product by standardizing of processes. Increased economy of processes is a separate aim that is never lost sight of. Practically every operation comes under the chemist's observation.

One example will indicate what intelligent study along this line will accomplish. For the first grade of circular saws, inserted teeth of tool-steel provide the cutting points. Drop-forged, these inserted teeth are hardened, tempered and annealed before machining and sharpening. For years, they came to the machines covered with a scale which ruined the edge of tools after a few operations. Investigation showed that this scale was formed in the annealing bath of powdered charcoal

and that it was due to oxidization coming from exposure to the air. The chemist suggested air-tight boxes as containers of the charcoal dust—and the scale disappeared, cutting the cost of the machining operations in half. Knowledge of chemical combinations such as this is outside the province of factory foremen until the chemist points the way.

The organization of the works makes each of the chief departments—circular band, cross-cut, hand-tools, the foundry and machine shop for power-saw equipments and the handle mill—a self-contained factory.

Each of these departments has its own inspectors who scrutinize the results of the operations for which the department is responsible.

There is a final inspection before packing and transfer to finishing stock, or in case of a special order, to the shipping department. Analogous tests are made of tension, gauge and other vital qualities in hand-tools, circulars and hand saws.

Thorough inspection insures the customer of receiving satisfaction in every one of your deliveries. It lowers your production cost by doing away with a large percentage of wasted materials. The laboratory test of raw materials, finally, saves you from the danger of receiving unsatisfactory goods from your own suppliers.

THE *first requisite of an inspector is the possession of a sound and far-reaching judgment. He must recognize no favorites and must refuse to pass any work not up to specifications and drawings. He must be able to judge the importance of various parts as compared to the whole, to discriminate between different classes and qualities of work, as well as to look out for errors and mistakes on any of the drawings.*

—Frederic A. Parkhurst